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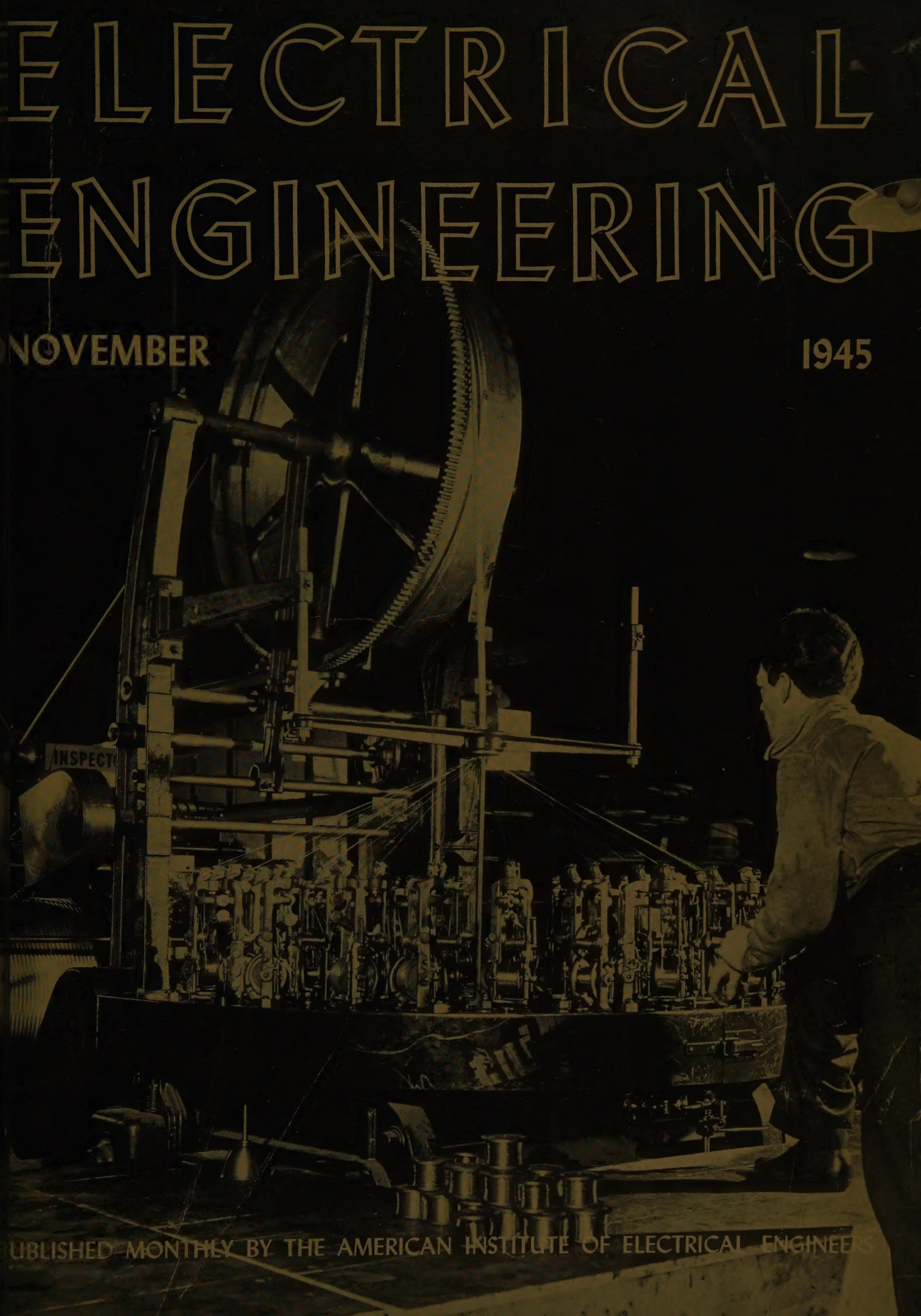
NOVEMBER 1945



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The Cover: Braiding machine in a radio-frequency-cable manufacturing plant; a report of a conference on these cables will be included in the 1945 *Transactions* volume and in the December 1945 "Supplement to Electrical Engineering—Transactions Section" (*see p. 409*).

Federal Telephone and Radio Corporation photo

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ELECTRICAL ENGINEERING
VOLUME 64, NUMBER 11 NOVEMBER 1945

Engineers and Scientists in Government Service

RALPH D. BENNETT
FELLOW AIEE

The problems of civil-service operation, with particular emphasis on the hiring and rating of technical talent, are considered in this article which is based on the author's experience in the Naval Ordnance Laboratory, Washington, D. C.

DURING THE WAR the armed services employed, either directly or indirectly, most of the best technical talent of the United States. The larger fraction was indirectly employed through industrial concerns having contracts with the armed services, or through the National Defense Research Council. However, a considerable number was in direct employment with agencies such as the Signal Corps Laboratory at Fort Monmouth, N. J., the Army Air Forces Laboratories at Wright Field, Ohio, and, in the vicinity of Washington, D. C., the Naval Research Laboratory, the David Taylor Model Basin, and the Naval Ordnance Laboratory. The writer's association with the last-named organization enabled him to observe the expansion of that laboratory to war strength and its operation under war conditions. It is on these observations that this article is based.

CONDITIONS IN SERVICE LABORATORIES

The onset of the emergency found the Naval Ordnance Laboratory understaffed for its job. It had operated on very small budgets for many years with the result that its technical talent had been stifled and restricted, and its contacts with the outside world were extremely limited. The situations of the other service laboratories were different only in degree.

In the light of developments of the last five years, the wisdom of allowing our service laboratories to languish in such a manner becomes extremely doubtful. For the lack of modern weapons, or countermeasures to modern weapons, many lives were lost. We spent billions for development of weapons under the pressure of war, where millions spent in a careful, logical, peacetime program would have sufficed. We scurried frantically on many occasions to work out countermeasures to new enemy weapons against which we were totally unprepared. And we were reduced time and again to copying weapons introduced by the enemy because they were better than those which we, with our late start, were able to develop on our own.

After the first World War we sought peace by discarding our weapons and hoping that the anarchic nations would follow our example. This procedure was unsuccessful and it is hoped that we do not try it again, even under the pressure of expedient economy. During this peace we shall have to maintain more effective armed forces than ever we have in the past.

The effectiveness of an armed force depends on its size, the mental and physical qualities of its members, and the quality of the weapons with which it is provided. In numerical size, and particularly in quantity of equipment, we were able to compete with all comers. In fact our great supply of equipment may have proved a definite hazard as there is every reason to believe that by the time it is needed again it will be obsolete and, if retained, may give us a false sense of security. In mental qualities, at the present state of practical genetics, we had to work with what was available, but we must not continue to let our educational program deteriorate. Our widespread technical education allowed our Armed Forces to use weapons more complex in nature than those of many of our allies and enemies. The inability of a large fraction of our young people to pass the physical requirements of the services is a cause for concern. The proposed universal military service will help this situation somewhat, and this may be its principal contribution to national security.

The primary requisite in the effectiveness of an armed force in modern war is the quality of its weapons. The maintenance of this quality for our Armed Forces was and will be the responsibility of our research and development organizations, and particularly those of the armed services. Therefore an examination into the difficulties encountered in the operation of these organizations is in order, with a view to strengthening them and improving their effectiveness, particularly in peacetime.

The effectiveness of a research and development organization depends upon men and facilities. With the assumption that facilities will be provided, since this is relatively easy, the promotion of effectiveness then becomes a matter of getting high-grade men and keeping them productive. The Government is under a handicap in both respects because it does not make a sufficiently aggressive effort to get the men, and because artificial restrictions seriously hamper the activities of those it does obtain. The restrictive procedures are particularly inappropriate when applied to research and development men because the value of these men lies in their originality and willingness to deviate from the established channels of thought and action.

GOVERNMENT HIRING METHODS

The expansion in technical personnel at the Naval Ordnance Laboratory was accomplished by means of contract hiring, a method commonly incorporated into Naval and other appropriation bills, whereby the bureaus may contract for the services of scientists and technicists at a fixed daily rate. The method was rather simple to operate, flexible in the adjustment of rates, and generally satisfactory for temporary employment. However, when the number of persons so employed be-

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Essential substance of an address delivered before a meeting of the AIEE Washington Section, October 10, 1944.

Ralph D. Bennett is a captain in the United States Naval Reserve, Naval Ordnance Laboratory, United States Navy Yard, Washington, D. C. He is on leave from the department of electrical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

came large, pressure was exerted toward the transfer of these persons to civil-service status. The terms of transfer gave Naval Ordnance Laboratory employees an increase in salary averaging several hundred dollars per year, in addition to the privileges of annual leave, sick leave, and retirement benefits. Yet the employees of the laboratory for the most part were reluctant to transfer, and a considerable number of the ablest men left the employ of the laboratory when the issue was forced. The most common reason given for reluctance to transfer was that the employee wished to keep his record clear of the stigma believed to be associated with a term of civil-service employment. While other motives were involved in some of the resignations, the feeling was very real and very strong. Unless this feeling can be alleviated in the minds of those from whom our governmental employees must be drawn, we shall continue to have difficulty in getting enough superior talent. The reasons for this attitude are multifarious and complex.

A superficial reason that active, energetic technical men often do not aspire to governmental employment is that they too rarely see persons of great technical accomplishment in such employ. There are two possible reasons for this; first, the Government may not hire its share of talented individuals, and second, for those of talent whom it does employ it too often fails to provide proper encouragement and an atmosphere in which latent talent can develop. Even when latent talent develops, the employee himself usually must furnish the stimulus to publicize his accomplishments.

Considering first the matter of hiring of technical men, governmental techniques are inadequate as judged by modern standards. For the great majority of positions, the procedure briefly consists, in normal times, of posting notices of examinations in public places, examining those who appear and present appropriate paper qualifications, scoring the qualifications and examination, and placing the names in order of standing on a "register." When a vacancy occurs, the agency in which it arises chooses from the top three names on the register. The agency in general will have only a paper record on which to base its choice. It will know little of the personality of the candidate and therefore will be in a poor position to estimate how well the candidate may fit the group in which it is proposed to place him. To remedy this the agency should have the authority and the funds with which to pay the expenses of prospective employees called in for interviews.

INDUSTRIAL HIRING METHODS

Contrast this system with industrial recruiting as practiced in normal times. The candidate has to make no application, fill out no forms, take no examinations, and await no rotation of registers. Representatives of the interested company visit his school (if it has a reputation for sound training) well before graduation time, examine his personal history and scholastic record, interview the candidate and his professors at some length, and if mutual interest arises may provide the candidate with a trip to the company's establishment. The candidate, if accepted, can go to work in a predetermined job at a predetermined time. He generally will be provided with much more information regarding the organization with which he is casting his lot than he would be likely to get if he were to go into governmental service.

Competition on this basis too often has an outcome unfavorable to the Government. In too many cases candidates for jobs apply to the Government only when, because of poor performance or personality defects, they have failed to find placement in industry. To remove this basic handicap, those having the responsibility for government employment of technical personnel must, among other things, set up an aggressive recruiting procedure in order to get a fair share of good talent. Furthermore, while the supervision of selection of technical employees may be carried out by a general agency such as the Civil Service Commission, the actual selection of individuals cannot be delegated successfully to such a general agency without setting up a severe handicap to building a strong organization of high quality. Each organization must be allowed more freedom in selecting its own personnel. Frequently the fourth or fifth man on a civil-service register is obviously better qualified for the position than any one of the first three.

Successful recruiting of personnel is associated closely with the measurement of ability and accomplishment. The measurement problem is formidable and no perfect solution can be expected. The value of a technical man may be assessed on two major factors, namely, straight technical training and experience, and personality. The former is relatively easy to evaluate, and is given fair consideration in present governmental methods of employment. Personality evaluation, on the other hand, is much more difficult, largely because the evaluation is subjective. The industrial method is to provide a trusted and experienced evaluator who obtains his data by means of interviews and inquiries. The Government has no equivalent counterpart. While personality is of relatively little importance in the lower grades, it is the primary factor on which leadership is based. Without a conscious effort to take personality into account in the employment of its personnel, it is hard to see how the Government can avoid continuing to find itself deficient in material from which leaders can be made.

A factor which is causing much concern at present in many Federal agencies is the preferential treatment granted veterans. A concrete example of the working of this law, together with an inadequacy in present measuring methods, has come to the writer's attention. A professional scientific position of intermediate grade was open. Two candidates were available. One was a recent graduate in his early 30's with an advanced degree, who had finished with distinction in a school of established reputation, and whose interests and outlook well fitted him to fill the position and to become a strong member of the organization. The other, a veteran in his late 50's, finally had failed after a long career of teaching in an inferior institution. According to the law, with his veteran's preference, the latter had a prior claim on the position. Obviously such a candidate would become a clinging liability to the organization. Fortunately it was possible to leave the position unfilled pending a more propitious outlook, but the organization lost the services of a young man who might have contributed much. The present law gives veterans such a great artificial advantage that it seems unlikely that any persons other than veterans will be employable by most agencies for many years. While in purpose the law is commendable, no doubt a method could be found for accomplishing the desired result which would be less expensive than making certain, as the law certainly will in many cases, that persons of inferior basic qualifications are selected to operate the Government, our biggest and most expensive industry. The law should not make mandatory the placing of veterans in the top three positions on a register, over the heads of more able and more desirable candidates.

MEASUREMENT OF EFFICIENCY

The measurement of "efficiency" is another problem which is solved very imperfectly. While the present system is the outgrowth of many arduous and sincere efforts, when applied to technical men it still seems to have several salient defects. First, a rating blank is used which is designed to cover a wide variety of jobs, and hence is particularly suitable for none. Second, the grade is reported in detail to the employee, which puts the supervisor in a position of having to defend his grading. This has obvious merits, but since a low grade is likely to cause unpleasantness no matter how well merited, and there is no penalty for giving an unjustified high one, nearly all grades are high. The average for those agencies for which the information was available lies somewhere between the highest and the second highest of four satisfactory grades, with over 80 per cent in these two categories. With this narrow spread of grades the ratings are of little use in judging relative or actual value of the individuals of a group. A system of pay increases such as now exists based on these ratings becomes of doubtful incentive value. A possible remedy is to provide a form which will be better adapted to evaluating technical men, so designed that a differentiation will be made over the scale of effectiveness, evolve and take into consideration an index for each supervisor based on the severity with which he grades, and use the results in a realistic manner for the improvement of the service.

Except for a few of the most highly responsible positions, a Federal agency under the current regulations becomes a collection of jobs, which can be and are described on paper, and "allocated" by a reviewing agency into categories according to responsibility and difficulty. These jobs are viewed as entities, detached and separate from the persons who do or may occupy them. Each pays a predetermined salary according to its category. Similarly each person is viewed as another kind of entity to which a grade or magnitude can be attached, based on training and experience. Staffing the agency then becomes a matter of selecting an appropriately tagged individual for each labeled job. The individual's tag must indicate that he is qualified to hold a job of as high or higher grade than the one into which he is to be inserted. Promotion then becomes a matter of moving individuals from job to job as the jobs are vacated by promotion, resignation, or other contingency.

While this conception of an agency tends, theoretically at least, to insure that money will not be spent to pay persons for whom no real jobs exist, it runs into difficulties in a research and development organization. In the first place, in a live organization of this type the jobs change with kaleidoscopic frequency and variety. Therefore, to keep the job descriptions current and accurate is a Herculean task, and the work involved even in approximating this goal constitutes a severe drain on the strength and patience of men who are trying to do scientific and technical work. In the second place, under this system, no means is provided for hiring the type of creative genius which makes its own job, and without whose presence the job does not exist. Actually, under the pressure of war, such persons were hired, but in normal times for the civil service to hire a man, as contrasted to filling a job, is not an acceptable procedure. Since a research and development organization, by its nature, counts progress by the unpredictable results flowing from the work of creative people, the lack of a straightforward method of employing such men is a serious handicap. In the third place, men who make substantial progress usually are not content to wait for circumstances beyond the control of their employers to remove the person ahead of them.

The static nature of governmental agencies is enhanced by the fact that persons of long standing in the service are too rarely qualified for, or interested in, other employment, and even more rarely leave the service. Even though the law provides for it, they are rarely moved out but, unfortunately, sometimes are moved up, even though of doubtful competence. This may result in further enfeeblement of leadership which is already none too strong. A factor which tends to prevent the infusion of new blood and tends to advance incumbent incompetence is the substantially higher qualifications necessary for an outsider to move into a job over those required of an insider to move up. Still another factor obstructing advancement is the difficulty in getting technical jobs appropriately classified. The law provides for recognition of technical responsibility as independent of administrative responsibility. However, the administration of the law as far as classification is concerned is often in the hands of persons of clerical training and background. To such persons the pyramidal type of clerical organization is familiar and understandable. But to them the evaluation of technical responsibility in an unfamiliar and little understood field is difficult and often requires much discussion and delay.

In order that we may have more effective governmental research and development organizations, the concept of an agency as a group of jobs to be filled must be liberalized, provision must be made for the employment of the person who creates his job, and the unusually gifted must be encouraged and rewarded more generously and promptly than has been possible in the past.

THE SALARY INCENTIVE

Before the war the pay scale for the purely technical person was, by and large, adequate, save for the senior positions. The pay in the initial grade was some 30 per cent higher than that for corresponding positions in industry, and annual leave, sick leave, and retirement benefits were relatively liberal. The recent adjustment is not likely to meet postwar competition in the higher pay levels. For these positions, which were relatively very much underpaid as compared with work of similar responsibility in industry, the new law provides relatively small pay increases. The superior rates in the early grades probably facilitated and will continue to facilitate the hiring of young men, but they tend to attract the shortsighted. The difficulty in achieving recognition of purely technical responsibility already mentioned in part limits access to the higher rates of pay to fewer persons than is desirable in a research organization. The pay scale fails by all comparative standards to provide adequate rates for high administrative positions. When the Government asks a technical man to leave his technical specialty and undertake the responsibility of the administration of a technical organization, it does not, as in industry, reward him by a substantial increase in salary. This is an important factor in the existing situation where persons of superior leadership who have proved themselves cannot be induced to enter Government service unless they are privately endowed or willing to take a substantial loss in income. Similarly, there is relatively little inducement for a Government employee who demonstrates leadership to stay with the service, since in the service he never can be rewarded in a degree comparable to that which he can receive in industry. Many of the ills of the present system are directly attributable to this failure to provide for superior leadership and they can be expected to persist until this need is recognized and satisfied.

PROFESSIONAL DEVELOPMENT

Those responsible for the operation of governmental technical agencies often take too little interest in the continued development of their professional employees. The appropriations made for the purpose of sending naval professional employees to technical society meetings has been comparable in the past to that provided by a medium-sized university, employing perhaps one-tenth the number of professional personnel. This contributed to the condition at the start of the war in which a great many of the naval technical employees not only were ignorant of recent technical and scientific developments, but they were unacquainted with the authorities and organizations which could instruct them or supply their needs.

Publication of the results of researches provides a most valuable means for furthering professional contacts and stimulating creative work. Workers in the laboratories of the Armed Forces suffered a serious disadvantage in this respect because of security requirements. However, much of their work can be published and it is essential that the most liberal policy possible be employed in this matter. The contacts lost by lack of publication in a measure can be replaced by other procedures such as the interchange of personnel among research activities within the services, the detailing of personnel for substantial periods to university or industrial laboratories, or by arranging exchange visits between specialists in service and industrial laboratories. The Naval Ordnance Laboratory has found industry very receptive to such proposals. The Naval Laboratories can do much to stimulate interest by sending their technical men to sea for short periods. Many such methods are available to leadership alert enough to recognize and insist upon the importance of professional development.

Another problem in the operation of a Government research and development organization which is not a personnel matter, but adds to the difficulty of interesting competent men, is the complex purchasing system under which they are required to operate. The desirability of a system designed to hold cost to a minimum is obvious. However, when applied in detail it may defeat its purpose as the process of acquiring an item at minimum cost may introduce frustrating delays which are expensive out of all proportion to the immediate amount involved. This is largely the result of the establishment of regulations to control purchase of large quantities of routine types of material without recognizing the highly specialized needs of the technical worker for material which costs relatively little. A wider opportunity for the application of judgment should be allowed in the purchase of equipment and supplies in experimental quantities.

The preceding recital of current difficulties with governmental employment of technical men combines to present a gloomy picture. However, out of fairness to those who have struggled with the problems of government employment through the years, and to those scientists of agencies such as the National Bureau of Standards, the Department of Agriculture, and similar establishments, who have made substantial contributions in the face of these difficulties, the progress made in the past should not be forgotten. The Government technical administrators have highly ethical standards and, if given a free hand, the technical agencies of the Government would be operated more effectively than at present. However, experience in the United States indicates that such administrators would not long have a free hand. Irresistible political pressure soon would be brought to bear to the great detriment of any agency susceptible to it. The civil-service system was established primarily as a bulwark against such devastating pressures and has served well in that capacity. While eliminating former evils, the system has brought new ones which, while less vicious than those which existed previously, are nevertheless in urgent need of correction. The war focused widespread attention on these evils. The present is a propitious time for improvement and, while the process undoubtedly progressed slowly from the point of view of national defense, it would need acceleration if we are to reach and maintain a leading place in readiness to defend ourselves.

SUGGESTED IMPROVEMENTS

The principal steps needed to effect substantial improvement in the governmental technical service may be summarized as follows:

1. Achieve substantial and durable public recognition of the value of a comprehensive governmental research and development program.

2. Acquire in technical agencies a superior leadership which will utilize the provisions of present laws and regulations to their fullest and most beneficial extent and which will point out articulately changes which are needed. Such leadership must be compensated in cash and prestige.

3. Prosecute an aggressive recruiting procedure which will present the needs of the governmental technical agencies in a modern, imaginative manner and will compete energetically for technical talent at its sources.

4. Improve the measurement of technical talent so that governmental evaluation of quality in a technical man will agree with the judgment of his profession, and hire and promote on the basis of such measurement.

5. Recognize that genius creates its own job, not fills one prescribed by men of lesser imagination; and make provision for a fair share of genius in the Government.

6. Provide for and insist on continuous professional development in its broad sense on the part of technical employees, as an essential for continuation or advancement.

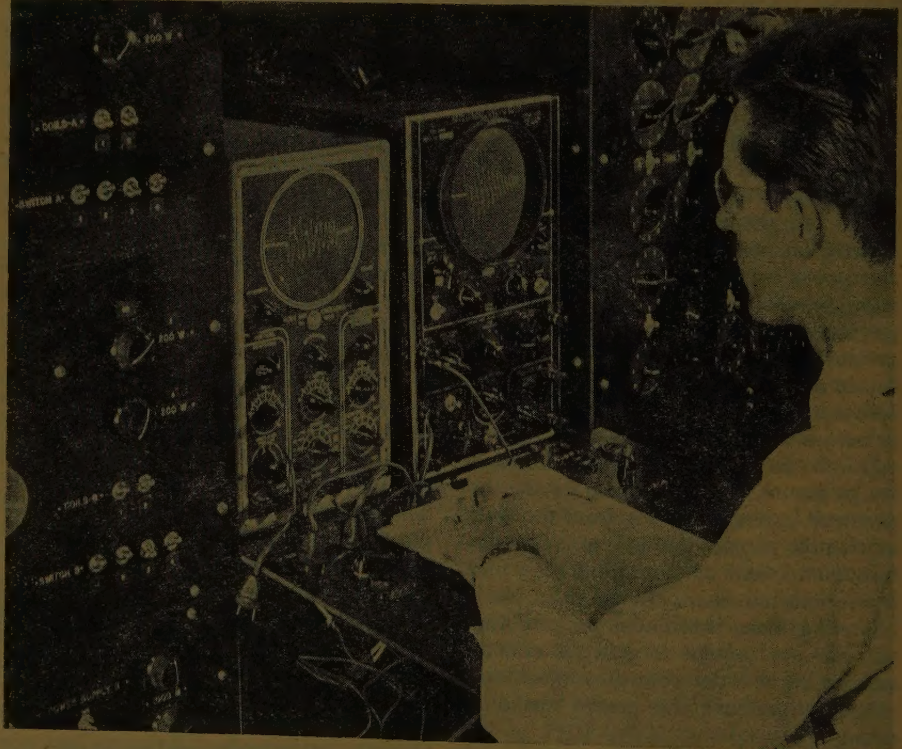
7. Effect the most liberal interpretation possible of the requirements of security as applied to publication by members of the laboratories of the armed forces.

8. Refuse firmly the promotion of mediocrity, and encourage the promotion of talent by provision for humane disposal of the decadent.

9. Provide flexibility and speed in the purchase of experimental materials consonant with an over-all conception of cost.

The persons responsible for the execution of the naval research and development programs are well aware of the difficulties that have been outlined and are ready to exert great effort in alleviating them. However, many other groups, both within and without the Navy, are involved, and some of the remedies are so basic as to require action by the Congress. These groups whose responsibilities are indirect and widely inclusive deal with the great mass of Federal employees and their rules and regulations are designed for the mass. To meet the needs of the special group of technological professionals, which totals at present less than three per cent of the whole, presents a serious problem in the face of the demands of the other 97 per cent. Nevertheless, the increasing part played by technology in life in general, and in Government in particular, enhances the importance of this minority, and therefore its needs merit serious consideration. Failure to meet these needs in a way which will strengthen substantially the military research and development organizations of the country may leave weak a vital link in our national defense.

Robot Solves Equations



An electric robot "quiz master" which computes problems by means of electric circuits and transmits the answers through the lines appearing on the fluorescent screens showing the reactions of electricity in combinations of coils and resistors that simulate the mechanical factors in a problem. This apparatus, known as a mechanical transient analyzer, was developed by the Westinghouse Electric Corporation to aid its engineers by solving mathematical equations in a fraction of the time required by ordinary methods

Aviation Communication Systems

D. W. RENTZEL

A review of the past, present, and probable future communications requirements of aviation is presented in this article which includes an analysis of the progress that has been made to date together with some predictions of and suggestions for developments to come.

American Air Lines photo

TO DISCUSS at any length the many and complex needs of aviation for communications and the varied methods by which these needs may be met would require a great deal more space than is available. Aviation is the largest single industrial user of communications in the United States today. However, it is believed that a reasonably clear picture of the problems and needs may be established briefly and some suggestions may be offered in this article. Aviation is looking anxiously to the radio and electronic industry for the ultimate answer to problems yet unsolved. Until the members of the various communications groups and the manufacturers make available additional equipment in a form which can be used commercially, the needs of aviation for communications and air navigation cannot be fully met.

STATUS OF AVIATION

The history of aviation communications, and this term is used broadly to include the transmission by radio and electronic methods of all intelligence required to enable safe flight, naturally falls into two periods of development. The first period began shortly before World War I and extended to the years 1929–30. The second began in 1930 and extends to the present. The future era has begun and the utilization of developments since 1940 will open new and promising vistas to us.

The first records of attempts to use radio transmission experimentally from airplanes in flight to stations on the ground date back to 1910. The United States Army and Navy each tried out such apparatus as was available and were able to transmit intelligence by means of radio-telegraph signals for distances of from eight to ten miles. The idea at that time was to utilize aircraft for artillery spotting. As late as 1915 there was unanimity of opinion that an airplane never would be able to communicate beyond spotting ranges because of the limited weights which it could carry. This, of course, limited the size of radio equipment. But industry met the challenge and in 1916, in conjunction with the Navy, a scouting airplane radio transmitter was developed. Radio became of such vital importance during the first World War that the first military radio laboratories were established under the direction of men such as Rear Admiral S. C. Hooper and Colonel C. C. Culver. The necessary and vital research programs to develop aviation communications for military purposes, which were to benefit commercial aviation so greatly, were begun.

It will be noted that the Navy's problem in developing radio for its aviation needs was that of long-range communications for scouting purposes and direction-finding bearings. The Army's problem was short-range radiotelephone for artillery co-ordination. Both were accomplished successfully in close co-operation with industry in time to be available for World War I.

In 1919 the first publicized use of long-distance radio direction finding and communications for aviation occurred when the famous *NC* airplanes attempted their transatlantic flights. These airplanes were among the first to be equipped fully with radio, having aboard transmitter, receivers, trailing antenna, emergency batteries, wind-driven generators, and direction finders. The direction-finding equipment was to play a particularly important part in these flights as witnessed by the report of Lieutenant (now Rear

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Essential substance of an address before a joint meeting of the communications groups of the New York Sections of the AIEE and the Institute of Radio Engineers, April 26, 1945.

D. W. Rentzel is president, Aeronautical Radio, Inc., Mineola, N. Y.

Admiral) A. C. Read that but for direction-finder bearings he would have become lost between the Azores and Portugal. Thus, for the first time, the part radio was to play in the navigation of aircraft as well as a means of communicating with aircraft was graphically illustrated.

The first radio beacon, known as the radio phare, was developed in 1917 and came into extensive use for international aviation in the period which began in 1928. In this same period the need for navigation of aircraft along a fixed airway brought forth the development and test of the first radio range in 1929.

Radiotelegraphy for communication to aircraft was used for some years but the development of radiotelephone for this purpose was begun in 1929 and by 1930 airlines had adopted radiotelephone entirely, with the exception of the international companies who continued to use both types of emission to meet their needs. At the present time more and more radiotelephone is being used for air–ground communications in all types of aviation.

At this point it is worthwhile to explain briefly the broad requirements of aviation for radio communications and navigation. These can be listed best in order of appearance as operating functions on airplanes.

First; the need for two-way communications with ground stations. For obvious reasons the airplane must rely on radio to establish and maintain communications with the ground. Such communication must be instantaneous and reliable to the point of perfection because of the high speed of the airplane and its limiting factors such as inability to stop and wait for further information, and fuel limitations requiring a landing within certain time limits. It is extremely important, therefore, that weather information and meteorological data, airport conditions, and other pertinent facts be transmitted promptly to the airplane throughout its flight between points. This can be described as long-range communications.

After arriving at the point of intended landing or, in the case of airplanes operating in the vicinity of airports only, such as training flights, two-way radio communication is vital to segregate the airplanes in the vicinity properly and to give each airplane up-to-the-minute information on the sequence of landing, wind direction and velocity, and the condition of the airport and its runways. It can be described as short-range communications.

Secondly; a basic method of navigation between points. As mentioned briefly before, the airplane, as it is not bound by highways and other surface deviations and can fly directly to its point of intended landing, must create its own track in the air space. Obviously wind direction and velocity play an important part in such navigation, and the heading of the plane to achieve its straight flight path must be corrected. In clear weather this is done by visual reference to ground points in daylight; or reference to rotating light beacons at night; but, when low hanging clouds or fog reduce or eliminate visibility, radio must step in and create the safe track required. This is done at present by the radio range and radio beacon.

Briefly, the radio range operating in the 200- to 400-kilocycle band creates a path known as a beam or "on course" in four directions simultaneously by alternately keying four towers placed approximately in the shape of a square. By using the interlocking code signals *A* and *N* and alternate tower radiation the point at which the signals are heard with equal intensity blend into a steady monotone forming on the course or beam. Obviously the position of these on-course indications or beams in air space can be regulated, with certain limitations, by the placement of the towers and relative field strength radiated from each of the towers. By proper location of a network of these radio-range stations and co-ordinating their on-course indications to coincide, within adequate signal distances, airways in space are created permitting safe flight between any two points served by such facilities without any visual reference to ground points.

Such a system can serve any number of airplanes simultaneously. It is limited only by the spacing of airplanes to avoid collision. This spacing can be accomplished by vertical or horizontal separation. In other words, by altitude or time. The limitations of the present radio-range system will be discussed later.

Thirdly; a means of proceeding from the radio-range station to the airport under conditions of poor visibility. Although radio-range points are located near the airports they serve, a method of proceeding from the range station to the airport under conditions of poor visibility must be provided. This was accomplished until recently by arranging range-station locations so that one on-course indication passed over the airport providing a safe letdown path between the range station and the airport. By applying planned and tested procedures this method is satisfactory, with the limitation that sufficient cloud height and visibility are required over the airport for the airplane to maneuver safely underneath cloud cover after establishing contact with the ground in order to complete the landing. After considerable experimentation a supplemental program of installation of instrument-approach radio systems was inaugurated last year to augment military facilities already operating throughout the world. This approach system provides a runway radio beam or on course with marker stations located at proper points along the beam to indicate distance from the desired runway. The runway beam is formed by two modulation frequencies being transmitted simultaneously on separate and adjacent antennas. This results in overlapping bean-shaped lobes which create an electrical-equisignal on course on an indicator in the cockpit of the airplane. The on course or electrical-equisignal zone of this beam is centered on the desired runway, thus setting up a runway path. The marker transmitters located along the beam or on course, at known distances from the end of the runway, transmit an elliptical vertical pattern. A flashing-light indication and an aural indication in the headphones when the airplane passes over the marker station indicates exact position to the pilot. A third transmitter known as the "glide-path" transmitter is to be added to these ground installations soon. This transmitter will provide a beam in the horizontal plane indicating safe-glide angle through surrounding obstructions. This glide angle is established by the same methods used for the establishment of the localizer except that, in effect, the transmitting antenna are turned 90 degrees. Indication of the airplane's position in the horizontal plane is shown by the position of a needle on the same instrument in the airplane cockpit as is used for the runway localizer, thus permitting the pilot to bracket visually both beams to the zero point. Safe and accurate horizontal and vertical approaches thus can be made with distance measurements provided by the afore-mentioned markers. When these facilities are installed completely and all transport aircraft are equipped an increase in operating efficiency and safety will have been effected. Although personally owned aircraft may use these facilities, it is expected that because of the weight and cost of the airborne equipment such use will be limited for some time.

SUPPLEMENTAL NAVIGATIONAL DEVICES

Again, due to speed and other limitations, an airplane cannot rely solely on one means of navigation where daily flight regardless of weather conditions is contemplated. Therefore, scheduled or airline aircraft carry an additional device known as the automatic direction finder. This unit operates on the radio-range band, the standard broadcast band, and a supplemental international beacon band above the broadcast band, and gives a homing indication to the pilot when tuned to the desired station. It has proved valuable in checking navigational paths and in obtaining wind-drift indication. In operation over large bodies of water, in the international service, where radio ranges are not provided, it has become a primary means of navigation, as a supplement to celestial navigation fixes. Lately new long-range navigational devices have been added. The automatic direction finder operates by automatic homing on the balanced-loop principle of a shielded loop measured electrically against a sense antenna out of phase with the loop. A received signal will cause the loop-motor mechanism to rotate until a null is achieved. By direct reading methods this loop position is indicated by an arrow on an azimuth scale in the cockpit thus giving homing indications continuously on the desired station and tracking the station when the airplane is maneuvered. Tracking information is invaluable to the pilot for many purposes.

Ground direction finders also are used extensively in the international service operating on the communications channels in the high-frequency band. In the European areas low-frequency transmissions from the airplane also are used. The latest versions of these direction-finder stations operating in the high-frequency band give electrical azimuth indications, from a rotating loop or loops of the incoming signal and serve well as an auxiliary indication of an airplane's location. Obviously triangulation fixes are only a matter of co-ordinated ground direction-finder stations. It is expected that such stations will continue to be useful, operating in the high-frequency bands for the international overseas aviation service, particularly in air–sea rescue work, and as a supplement to other facilities for emergencies.

FREQUENCIES

The frequency problem is of particular importance to aviation because of the time conquering attributes of the airplane and its disregard of geographical barriers. Aviation never can expand properly unless frequencies, procedures, and methods of navigation are standardized broadly internationally. Otherwise, unnecessary stops, duplications, and complications of airborne equipment and complexity of procedures will retard the growth of aviation between countries and throughout the world.

Frequencies for communications. Present frequency bands used for aviation communications are largely in the high-frequency bands. Those used domestically are concentrated in the 3-megacycle and 5-megacycle bands and internationally 6-megacycle, 8-megacycle, and 11-megacycle bands are added to provide optimum frequencies for long-distance operation over large bodies of water. These frequencies have proved very satisfactory, making possible continuous communications over extreme distances with the limited power and antenna characteristics of the airplane. A trend toward the very high frequencies for certain types of communications, particularly short-range control, now has been initiated to supplement the high-frequency channels, so valuable for all types of international services, and therefore extremely limited. Very-high-frequency bands allocated to the aviation services by recent Federal Communications Commission proposals provide a band 122 megacycles to 132 megacycles for communications purposes and 75 shared channels in the 225-megacycle to 400-megacycle band. From these bands will come channels for privately owned or personal aircraft, commercial, scheduled and nonscheduled aircraft, and lighter-than-air ships. Operating on 118 megacycles to 122 megacycles will be control stations transmitting to all types of aircraft. The latter stations include the military when using commercial airports.

The high-frequency band, while permitting long-distance communications between aircraft and ground stations, has certain disadvantages which can be offset to some extent by the very high frequencies just as high-frequency bands offer very definite advantages and disadvantages over the low- and medium-frequency bands to aviation.

High-frequency channels, being affected by movements of the heaviside layer, require channel assignments in pairs, or a family of frequencies in the case of international long-distance aviation, to provide day and night coverage in skip conditions. Lower frequencies are used at night and high frequencies in day to cover the same distance. This complicates the airborne equipment and requires multichannel transmitters and receivers. At the present time, ten channel transmitter–receivers weighing 65 pounds with an output of 60 watts are standard. The long-distance-transmission features of the high-frequency bands also limit the number of times a frequency may be shared without interference which requires more channels to be assigned. However, these features are also advantageous in long-distance operation on low power and the high-frequency band is the only band having this advantage. High frequency bands also are affected less by static than are low and medium bands but very-high-frequency bands offer almost staticless communications. Very high-frequency, however, as is well known, being limited to line-of-sight communications offers complications to low flying aircraft. Repeater stations, or considerably more stations, are required to maintain the continuity of communications required and cannot be used extensively in the international aviation services or for long-distance domestic-aviation services because of the impossibility of providing the necessary stations over large areas of water, jungle, or undeveloped territory. Very high frequency also has some disadvantages in extremely mountainous terrain for the same reasons so it is necessary that both bands be used to cover the needs of all types of aviation for communications with future emphasis on very high frequency.

Very high frequency offers some weight saving as a result of lower power requirements. The shorter lengths of antenna required present a definite advantage to aircraft as it is possible to house some antennas inside the surface of the airplane or greatly reduce exterior lengths of antennas and so reduce aerodynamic drag. Provision of antennas of better radiation characteristics is also possible.

An additional band of frequencies in the vicinity of 1,500 megacycles has been proposed for assignment to aviation and it is to be hoped that these channels will be even more useful for limited-distance communications in the next five years.

One additional advantage of the very-high-frequency bands to aviation is the elimination, to a great extent, of the effect of the phenomena known as precipitation static, caused by passage of the airplane at high speeds through highly ionized cloud formations. The resulting high-voltage charge on the airplane's surface discharges across antennas with sufficient intensity, particularly in low temperatures, to cause receiver blocking and temporary loss of communication on lower frequencies.

Frequencies for navigation. At the present time, low and medium frequencies are being used for navigational purposes by aviation. As mentioned previously the radio ranges operate throughout the world in the 200-kilocycle to 400-kilocycle band. These are supplemented by radio phare beacon operations in the international service in the 1,600-kilocycle band, particularly in the central latitudes and for daylight operation. New long-range navigational devices for overseas operation operate in the 1,800-kilocycle to 2,000-kilocycle bands. These devices, using electronic methods for measuring distance from land stations, offer great promise for long-range highly accurate navigation for both maritime and aviation services and promise a great improvement over present methods of navigation over large bodies of water. Much experience has been gained in the last two years in the utilization of such facilities and consequent improvement in techniques.

At this time it might be well to point out that modern maritime and overseas aviation navigational practices and methods should begin to merge in the postwar era and close co-operation between the two services is indicated and extremely desirable. The supposed competition between the two types of service has no part in the safety services. Aviation is ready and willing to share navigational aids where possible.

Frequencies proposed for the instrument-approach facilities now being installed are 108 to 112 megacycles for the runway localizer and frequencies in 330-megacycle bands for glide-path transmission. Seventy-five-megacycle marker assignments are operated at present for both airway and approach markers but it is likely that these assignments will be changed to higher frequencies or possibly eliminated because of technical developments within a reasonable time now that the war is over. A considerable investment is represented, however, and for production and installation reasons alone the transition cannot be a short one.

A new band for radio ranges has been assigned from 112 to 118 megacycles. The present low–medium frequency assignments are far too crowded and are needed urgently for overseas and long-distance domestic service and must be supplemented by these very-high-frequency facilities for short-range service and low frequencies diverted to long-range needs. The prospect is, therefore, that very-high-frequency radio ranges will be in service soon and the domestic airways will be served primarily by these facilities. Instead of four "courses" established by aural methods the new ranges will be two-course visual indicating types and will provide electrical as well as aural on-course indication to the pilot. They will provide for more accurate identification of airplane position, the elimination of most types of static, and should be somewhat more reliable due to the absence of night effects.

These new very-high-frequency ranges will provide for conversion to omnidirectional types which will increase the number of on courses. Such a possibility offers many advantages, since, at the present time, all the air space between major cities is not being utilized by channeling air traffic, during conditions of poor visibility, along narrow airways. The omnidirectional range offers possibilities for creating more paths, therefore, and thinning out traffic congestion much as the opening of a new road or roads would do for automobile traffic, or the double tracking of a railway system would provide for additional railway traffic.

For experimental navigational purposes, to utilize the many new and promising devices over the horizon, Panel 11 of the Radio Technical Planning Board, representing aviation, requested, and the Federal Communications Commission concurred, in the assignment of bands throughout the very-high-frequency–ultrahigh-frequency spectrum providing for already existing facilities and new facilities now in experimental operation. One of the most important of these is the band 960 to 1,125 megacycles. Much hope is held for provision of a combination of several needs in this band which are to be described in the following paragraphs. Other bands offering especial promise at this writing are the 5,000-megacycle band and the band between 8,500 and 10,000 megacycles. However, with so many possibilities and developments, we cannot afford to overlook any possible solutions to our needs in any band.

MANY PROBLEMS UNSOLVED

The discussion to this point has been on what has been accomplished and what is now available in form satisfactory for use by commercial aviation. Many problems remain, however, which are crying loudly for solution at the earliest possible date. An attempt will not be made to present a too detailed discussion of these requirements, but this article would not be complete unless these needs were mentioned in general form. The items which are listed are not necessarily in their order of importance.

We are now looking to the "age of flight," the postwar period, in which radio and electronics must play a large part. The war period compressed many years of research on airplanes, engines, and radio and electronic equipment into a very few. Radio is guilty, at present, of trailing some of the other components of satisfactory and up-to-date air transportation and personal flying. Many of the factors preventing a completely safe and every day, on-schedule performance and the ultimate in personal airplane use are capable of solution only through radio and electronic methods. The solutions to many of these problems are in the offing, but they must be expedited and put into commercial form. The airplane user no longer is satisfied to get some place at some time. He expects and will demand dependable service and the ability to be assured of accurate arrival.

These are the major remaining elements needed to complete our aviation picture, capable of solution by radio–electronics methods.

COLLISION-WARNING INDICATOR

Pilots have always needed, and the need becomes more pressing with the increase in flying and flight speeds, some warning indication of obstructions, either mountains, buildings, or other aircraft. Unlike military requirements for similar equipment, full advantage should be taken of beacon transmitters on aircraft to identify other aircraft in the vicinity, and also to identify and locate obstructions. Such a device using electronic methods also could be used for continuous ranging from navigational beacons. Very general specifications for such an instrument should be:

1. Continuous scanning of an area of at least 15 degrees on either side of the center line of the nose of the airplane, preferably 90 degrees on either side of the nose, or a total sweep of 180 degrees. If possible that a substantial weight saving could be effected, the 90-degree sweep could be achieved mechanically by the pilot by some simple motor mechanism, the 15-degree sweep being continuous.

2. Should provide continuous distance indication, if possible on some type of counter device indicating distance in feet or yards.

3. Should indicate approximate elevation of obstructions with relation to aircraft position.

4. Should provide light or buzzer warning device when obstacle is within a preset danger area.

5. Weight should not exceed 50 pounds or should be less than 90 pounds if the instrument also serves as a radio altimeter and gives cathode-ray indication of azimuth location, distance, and approximate altitude of obstructions and radio beacons.

6. Should provide identification of all obstructions within 20 miles. Due to the high speed of new transport aircraft, this allows only four minutes or less for avoiding the obstruction.

7. Full advantage should be taken of ground stations to limit weight and power requirements in the airplane.

8. Power supply; should operate on 12- or 24-volt airplane system.

RADIO ALTIMETER

The radio altimeter was developed before World War II as a device to indicate heights above terrain vertically underneath. Some thought had been given to its possible use for instrument landing of airplanes to supplement the glide-path features of the instrument-approach system, but experience with its use indicated that needle flutter from obstructions in the path of the approach to the runway limits this use to water landings.

A new and important application for the radio altimeter has developed in overseas flights that makes its use advantageous for "pressure pattern flying" to take advantage of clockwise rotation of winds in high-pressure conditions, and counter-clockwise wind rotation in low-pressure areas as they move across the earth's surface.

Thus, by studying meteorological data before a long flight, a pilot may take advantage of these winds and not necessarily fly the shortest distance course, but fly the area having the best winds in order to afford the shortest time operation. The prime consideration in air travel is time, not distance.

The two most important instruments used in this method of "isobar" flying are the pressure altimeter and the radio altimeter. Variations in the reading of the two instruments give an accurate indication of pressure changes which, when analyzed, indicate regions of high and low pressure and indicate favorable courses.

The radio altimeter also is used to maintain clearance above terrain, proper elevation, and as a check on the accurate correction pressure-type altimeters.

It should have the following characteristics:

1. If possible, radio-altimeter functions should be combined with the collision-warning device.

2. Its range should be 40,000 feet, preferably on a low- and high-altitude scale.

3. Its accuracy should be at least within three per cent, with a stability of 30 feet over a period of 15 minutes.

4. Indication should be combined with the ranging measurement instrument, or on a counter type of indicator or cathode ray.

5. Some form of test button for service-test indications should be included.

AUTOMATIC POSITION REPORTING

One of the delaying factors in adequate air-traffic separation, in addition to the present channeling method mentioned in connection with radio-range systems, is slowness in exchange of information concerning location of aircraft, between the air and ground, and between airplanes. Although anticollision indication will be a tremendous asset, separation and priorities of movement must be controlled by an independent controller on the ground in the same manner as a policeman serves at street intersections.

Air-traffic control, therefore, must become more automatic through the following or other methods to speed up aircraft movements, under conditions of poor visibility, to approximate movements in clear weather.

1. Automatic position reporting to identify, locate, and give altitude of all aircraft in the control area.
2. Ability to duplicate this information to all interested parties which may approximate as many as 50 duplications.
3. Azimuth identification and range indication to be automatic and, if possible, altitude of aircraft to be indicated on same indicator. If necessary, altitude indication can be separate.
4. Ultimate simplification in this device, keeping in mind all information to be obtained with lightest weight of aircraft equipment possible.
5. If possible, sufficient meteorological phenomena should be indicated to denote location, range, and intensity of thunderstorms, and other turbulent cloud concentrations.
6. Device should be capable of such housing that it can be operated in all elements.
7. Costs and unnecessary gadgets to be kept to a minimum.

WRITTEN COMMUNICATIONS TO AIRCRAFT

Because of the volume of information desired in aircraft, particularly in scheduled or airline aircraft, a means of written communication to airplanes is a necessary and desirable unit. Such a unit, whether facsimile or radio-type, used with area broadcasting procedures, would make available a volume of desirable and necessary data with no appreciable effort on the pilots' part.

General specifications might be described as follows:

1. Should be of the page type as tests have proved that tape printers are unsatisfactory because of the necessity of scanning for information and inability to tear out desired portions of tape without reloading or rewinding difficulties.
2. Printer or facsimile aircraft unit should not weigh in excess of 25 pounds, exclusive of the receiver.
3. Some consideration should be given to the possibility of station selection by providing extra pulse combinations for this purpose.
4. Aircraft unit does not require a keyboard or transmitter as a necessity, but should be developed in both forms, if possible.
5. Care should be exercised in feeding out the paper in a fashion that will avoid jamming when the unit is not attended.
6. Minimum band width for transmission is a very important consideration.

It will be understood that, for the purposes of this discussion, the lists of requirements must be kept to general terms. The foregoing list is confined to desirable operating characteristics and so is far from complete. Quite naturally, too, information of a classified nature cannot be discussed or explored as yet. Perhaps later articles will be able to develop this thinking further.

There are other important phases of aviation communications which will be presented briefly without taking the time to go into much desirable detail. These phases are described in the following.

Aircraft Electric Systems. Basically aircraft electric systems did not change radically, although they were vastly improved, from 1928 until the period just prior to the outbreak of the war when a shift from 12 volt to 24–30-volt d-c systems was inaugurated.

At the present time, most airlines and private or personal aircraft are still utilizing the 12-volt system, and most military aircraft have been utilizing the 24–30-volt system.

From a recently completed survey of aircraft electric systems, it was concluded that the basic electric system in all aircraft will be 24–30-volt direct current in the postwar period although, for many reasons, high alternating voltage will be available and quite possibly may be the primarily generated voltage. It was further determined that 400 cycles would be the frequency generated for high-voltage alternating current.

A further complementary study of this most basic aviation requirement is being undertaken by an AIEE subcommittee on aircraft electric systems. Aviation is deeply interested and will lend every assistance to the completion of this work.

Airborne Equipment. One of the other phases of aviation communications and navigation demanding immediate study is the size, weight, and scope of airborne radio and electronic equipment. Size and weight of airborne radio equipment is a matter of great economic concern since each pound carried in accessories is a pound removed from payload for passengers, cargo, or increased range.

Due to the method of growth of commercial aviation, a new unit has been added as each new function has been developed. The result is a large number of units almost totally unrelated with some units, such as marker receivers, being utilized as little as two minutes on an average flight, yet performing an indispensable service.

With the advent of the new frequencies in higher ranges being assigned in adjacent blocks it is now possible to combine two or more functions in one unit. We look forward, with the co-operation of industry, to development of one package of related and integrated units to perform all required functions. Such a system, it is hoped, can be operated from a common power supply and should not exceed 200 pounds in weight. For international overseas operation supplemental equipment peculiar to these long-range needs would be added.

A specific example is the combination of instrument-landing localizer and very-high-frequency radio range into one receiving unit. These functions being performed consecutively, this is a very logical combination, the receiver being designed to operate from 108 megacycles to 118 megacycles.

With the advent of new techniques, more packaging would seem possible, and more functions can be combined into a single unit on a time utilization basis.

The same principles of packaging apply to the personal airplane. The manufacturer who builds a radio system for the personal airplane must build it so that new functions may be added to the system as required in more or less the sequence that a personal plane owner expands the use of his airplane, keeping cost and weight to a minimum. This should not be difficult as the new very-high-frequency assignments make such a planned system much easier to achieve than heretofore.

All personal airplane communications will be very high frequency, so we should start with the receiver for training plans and the transmitter–receiver combination for personal airplane contact flying. We add the very high frequency range feature when cross-country flying is contemplated, if possible incorporating ranging, and finally the instrument-landing functions.

In conclusion some mention should be made of the vast network of point-to-point communications required to tie together all the other features of aviation communications and provide integrated control.

The domestic airlines alone maintain nearly 50,000 miles of private-line teletype for their own exclusive use to transmit their operating and dispatching messages, reservations, and administrative messages, and the tremendous number of words required to maintain fleets of airplanes. Only through such communications can their operations be conducted efficiently.

The Civil Aeronautics Authority in addition operates over 40,000 miles of private-line teletype networks to integrate its domestic system of navigational aids, and to make available the large quantity of meteorological data required by aviation.

In international aviation, this problem is not solved so adequately as wired teletype does not exist. It is necessary to handle this volume of messages by radiotelegraph until radio-teletype is available, at which time it is hoped the changeover can be made to this method of transmission and greatly speed up and increase the word volume which can be transmitted over present radio circuits.

Transmission Networks for Frequency Modulation and Television

HAROLD S. OSBORNE
FELLOW AIEE

AMONG THE MANY postwar developments to which we look forward, frequency modulation and television are outstanding in interest and in promise and there is widespread confidence among broadcasters and others concerned that the future will see a great expansion in these arts.

It is recognized that one requirement for such large development will be the establishment of satisfactory networks by means of which the best programs can be made available to a large number of broadcasting stations, and the cost of providing such programs can be distributed over a large base. This is a natural conclusion from the experience with standard broadcasting which makes regular use of four national networks and a number of smaller networks provided by the telephone companies of the country. This article discusses plans of the Bell System Companies for making available transmission networks for frequency modulation and television and, as closely related to this, it includes a brief discussion on local transmission circuits, within a city, for both of these developments.

LOCAL CIRCUITS FOR FREQUENCY-MODULATION TRANSMISSION

Studio transmitter circuits for frequency-modulation broadcasting stations, at the present time and for the most part, use ordinary telephone wires in cable which are provided with special equipment. The Federal Communications Commission standards of good engineering specify that such circuits should transmit satisfactorily a band of from 50 to 15,000 cycles. Bands of this width have been provided for some of the standard broadcast circuits so that the introduction of this requirement for frequency-modulation broadcasting stations does not impose any severe new condition on the telephone circuits.

For this purpose the telephone-cable pairs are equipped with amplifiers at intervals averaging about eight miles. The circuit is equalized carefully throughout the frequency range to be transmitted and, in some cases, special steps are taken to reduce the noise level.

Of the 46 commercial frequency-modulation broadcasting stations in operation today, 40 are using telephone-wire lines. However, frequency-modulation stations often are placed on high points and there are a few places where the location selected is not readily accessible to telephone wires. In these cases radio is used to provide the connecting link.

INTERCITY NETWORKS FOR FREQUENCY-MODULATION BROADCASTING

At the present time those frequency-modulation broadcasting stations which are receiving network programs, generally speaking, are connected to the networks used by the standard broadcasting stations. These networks usually transmit a frequency band of 5,000 cycles.

In the past the telephone companies have played an important role in the transmission of television and frequency-modulation broadcasts. This article discusses their contributions to date and their program to provide facilities for the expected postwar boom in these arts.

Because of the high quality associated generally with frequency-modulation broadcasting, there has been some discussion of the probability that future networks for frequency-modulation broadcast stations should transmit a broader band of frequencies. Often a band of from 50 cycles to 15,000 cycles is spoken of as desirable, corresponding to the band now transmitted over local studio-transmitter circuits.

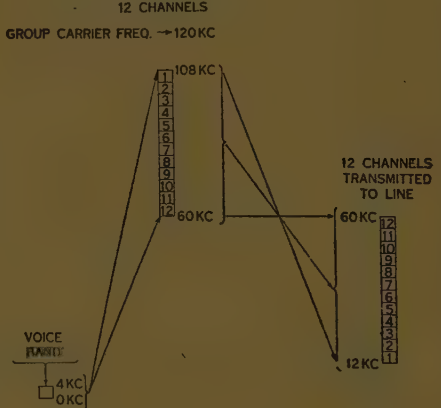

Figure 1. Frequency translations in carrier-telephone-terminal equipment (type K) for paired-conductor cables

The transmission of this broader band, or any fraction of it that may be decided upon by the frequency-modulation broadcasters as desirable, does not offer any serious problem to the telephone companies. This results from the fact that they already have a very extensive network of lines transmitting bands of 15,000 cycles or more all over the country for multiplex telephony. Generally speaking, on routes already equipped for transmission of these broad bands of frequencies, additional circuits can be equipped as required without difficulty. Furthermore, the continuing demand for additional telephone circuits is resulting in a continued extension of the mileage of telephone routes so equipped.

TYPE-K CARRIER SYSTEM

This favorable situation has come about through the continued development and extension of use of "carrier" telephone systems to provide multiplex telephony for the long-distance telephone business. Such systems have been used to an increasing extent by the telephone companies during the past 20 years and during the past two years more than 80 per cent of the large increase in long-distance telephone circuits has been by the use of such systems.

The general features of carrier telephone systems are well understood. However, it is of interest to review briefly the system applied to telephone cables (the *K* system) which is particularly important in connection with the future extension of frequency-modulation networks. This system is used on ordinary cables consisting of pairs of 19-gauge insulated wire. Figure 1 shows diagrammatically the frequency arrangements of the multiplex telephone channels. A four-kilocycle band is assigned to each voice channel. Twelve such bands are packed closely together in a 48-kilocycle space between 60 and 108 kilocycles using single-side-band technique with suppressed carriers. This 12-channel band is a basic feature in a number of carrier systems. When the transmission is to be over paired-cable conductors, the band is reduced by a second modulation to the frequency range 12 kilocycles to 60 kilocycles as indicated in the diagram.

A similar system is used for transmission over open wire but with somewhat different frequency allocation and with provision for transmitting over the same pai

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Essential substance of a paper presented before a joint meeting of the Washington Sections of the AIEE and the Institute of Radio Engineers, February 13, 1945.

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of conductors, at different frequencies, the two blocks representing transmission in opposite direction.

Bell Telephone Laboratories have completed the development of two arrangements for using these broad-band carrier systems for program transmission. One arrangement consists of an 8,000-cycle single-side-band system arranged to displace three telephone channels and to permit the continued operation of the other nine. An 8,000-cycle band was chosen for this system because it matches the 8,000-cycle program-transmission system already available over many thousands of miles of telephone route.

The second system which has been made available is a double-side-band system using the space normally occupied by 12 message channels. This system can give any band width up to 15,000 cycles, or even more if it should be desired.

FREQUENCY-MODULATION NETWORKS

The availability of these systems gives the telephone companies a wide degree of flexibility in meeting future requirements for frequency-modulation broadcasting stations. There is, first of all, the possibility of networks of the type now commonly used for standard broadcasting transmitting a band of about 5,000 cycles. There is a broader band system transmitting about 8,000 cycles which has been a standard offering of the telephone companies for about ten years, but which, so far, has received little use. The facilities already in the telephone plant and the adaptation of broad-band multiplex telephone systems for the use of this system make it possible for the telephone companies, on reasonable notice, to provide networks of this type. There is also the 15,000-cycle type of circuit which already has been designed for routes transmitting Type-*K* carrier systems and which readily can be adapted for transmitting over other types of broad-band systems.

The situation may be summed up by saying that with the relaxation of war restrictions, the frequency-modulation broadcasters should be able to receive nation-wide networks meeting any transmission requirements which they may select as desirable.

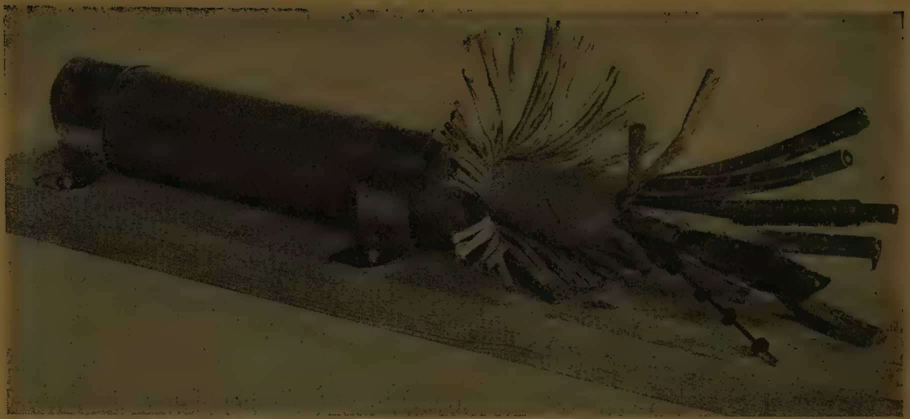

Figure 3. Cable with six coaxial units and layer of 19-gauge quads

TELEVISION TRANSMISSION WITHIN CITIES

For television transmission, as for frequency-modulation broadcasting, short circuits within cities can use specially equipped ordinary telephone pairs. The special equipment and other rearrangements necessary in the case of television transmission are illustrated by Figure 2 which shows diagrammatically a circuit of this type about 1.6 miles long in New York City. In order to get a direct route and use the maximum sizes of conductor available it was necessary to open cables and make special splices between subscriber cables and trunk cables as indicated. The subscriber cables were opened at other points to cut off bridged taps which seriously would affect the high-frequency transmission. Amplifiers were installed at both ends and at one intermediate point. With those amplifiers equalizers were installed and, at the two ends of the circuit, predistortion and restoring networks. The equalizers were adjusted on the basis of over-all transmission tests throughout the range of frequencies to be transmitted and measurements were made to determine that the noise was sufficiently low. The over-all transmission loss of the circuit at four megacycles, without amplifiers, would be approximately 100 decibels. Upon completion of the work, and with the amplifiers and the equalization installed, the circuit transmitted a band of four megacycles with zero over-all loss and was equalized throughout the band, both for attenuation and for phase, to limits that provide satisfactory transmission.

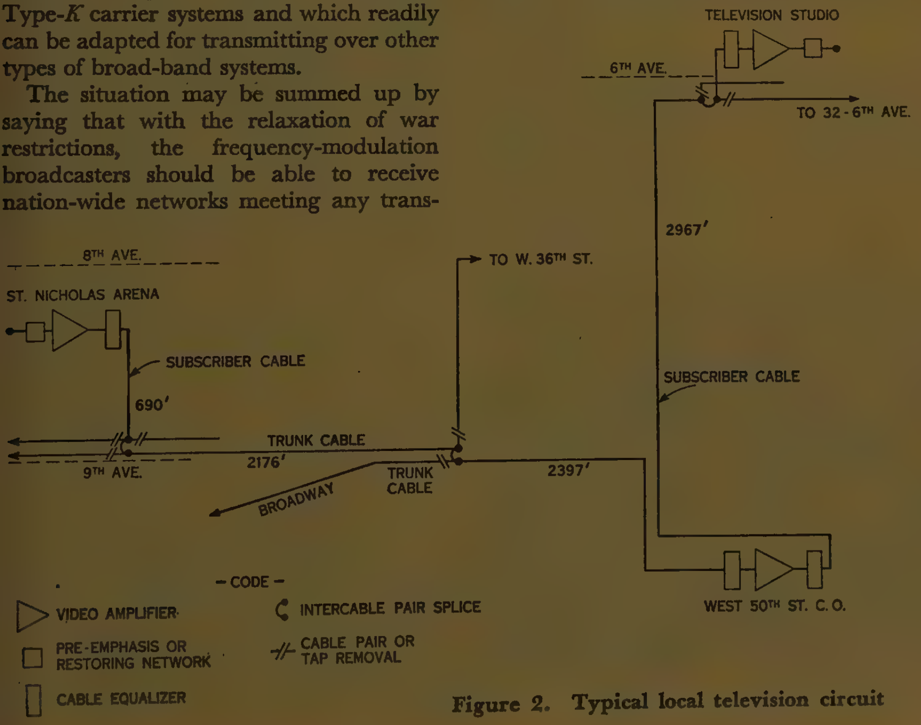

Figure 2. Typical local television circuit

The telephone companies have been providing a few circuits of this type for about five years. An alternative to using ordinary telephone pairs is to use coaxial cables or special shielded pairs. Both of these types are in use. Pulling a small cable meant exclusively for television into a city duct is a relatively extravagant use of duct space, and such special conductors can be provided most economically if they are included in full-size cables along with pairs provided to meet telephone requirements. To do this, however, requires long-range planning, as telephone cables generally are designed to meet prospective requirements for a number of years.

TELEVISION TRANSMISSION OVER INTERCITY CIRCUITS

The continued search of the telephone companies for increased efficiency in use of conductors for multiplex telephony has led to the development of a system suitable both for multiplex telephony and for television transmission. This is commonly spoken of as the coaxial-cable system because of the form of conductor used.

The 12-channel multiplex telephone system already has been described briefly. This system is used throughout the country on ordinary telephone pairs and occupies a band of frequencies from 12,000 to 60,000 cycles.

Placing still more channels on one pair would mean using still higher frequencies. As the upper limit of the frequency range is raised, the difficulties of providing suitable transmission paths become increasingly formidable. One major difficulty arises from the necessity of reducing to truly microscopic proportions the transfer of energy from one pair of wires in a cable to any other. With 100 or more pairs of wires packed tightly together, this is a great task, even at frequencies up to 60,000 cycles, and it becomes progressively more difficult as the frequency range becomes higher. While it is a matter of judgment as to just how far to go, it is evident that telephone pairs of a conventional design are not adapted for the transmission of very broad bands of frequencies over long distances.

For a solution of this problem shielding naturally is indicated. However, if we are to use a shielded conductor, the logical thing is to ignore the traditional form of telephone cable and design a conductor suitable for the transmission of very high frequencies. Consideration of this problem leads naturally to a very simple and classical form of conductor; the coaxial unit consisting of a cylindrical conductor surrounded by a cylindrical shield which also acts as a return conductor. The space between the two is, as far as possible, gas insulated to minimize losses at high frequencies.

In the solution of the problem the aforementioned conductor design was selected. Through a very extensive development process means were worked out for building such conductors economically on a large scale and of such design that several could be grouped together under one lead sheath and used under practical conditions.

The width of frequency band which can be transmitted over such conductors is primarily a matter of the design possibilities of associated equipment. The equipment now in use with the coaxial system is capable of transmitting a frequency band up to about 3,000,000 cycles. With this equipment we find it possible to transmit 480 telephone conversations simultaneously without mutual interference.

TECHNICAL FEATURES OF THE COAXIAL-CABLE SYSTEM

Some of the interesting technical features of the coaxial-cable system can be noted by reference to a few figures. The cable itself is made up as indicated by Figure 3. Generally speaking, a number of coaxial units and a number of ordinary paper-insulated paired conductors are included under the same lead sheath, the number of each being determined by the expected future service requirements to be taken care of by the cable over a number of years. This particular cable contains six coaxial units and 42 pairs for telephone use and is a section of a cable installed between Terre Haute, Ind., and St. Louis, Mo., to increase the telephone facilities on that portion of a main route between New York, N. Y., Chicago, Ill., and St. Louis.

These cables generally are placed underground by the use of a plow train. Three caterpillar tractors connected in tandem are followed by a rooter plow which prepares the ground for the cable, then by a fourth tractor backed by the cable laying plow, and finally by one or more trailers carrying reels of cable. This entire equipment is connected as a single train and as it advances the cable automatically is fed off the reels through the plow and buried at a depth of 30 inches or more in the earth (see Figure 4).

Essential elements of the system are the amplifiers which are placed in the cable at intervals of about five miles.* One such amplifier is indicated in Figure 5. It is a three-stage amplifier giving about 50-decibel amplification at three megacycles, provided with negative feedback, and so free of distortion that the currents of hundreds of different telephone channels covering a frequency band of 2,000,000 cycles can be transmitted across the country through hundreds of these amplifiers without mutual interactions sufficient to cause any interference.

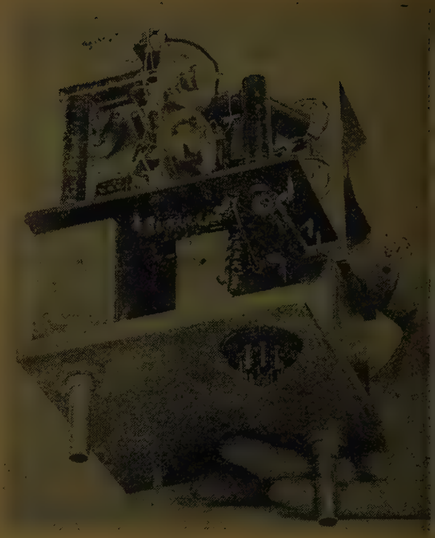

Figure 5. Coaxial amplifier

Figure 6 shows the assembly of two amplifiers and auxiliary equipment in a case suitable for connection into a pair of coaxial units at one point. The two amplifiers are the two square black boxes near the top of the case. Above them is automatic regulating equipment designed to counteract the variation in loss caused by variations in temperature of the cable. These regulators make a very interesting application of thermistors whose temperature is controlled by the flow of a pilot current over the circuit and which, by their variations of resistance with temperature, provide automatic compensation. The compensation at these repeater points is supplemented at main repeater stations 50 to 80 miles apart by a supplementary over-all compensation. This compensation is controlled by pilot currents of four different frequencies which represent all parts of the transmitted-frequency range.

A fundamental feature of the coaxial-cable system from the standpoint of economics is that the cable is its own power-transmission line. Power for the amplifiers is provided over the cables from main repeater stations, perhaps 80 miles apart. The equipment for taking off the necessary amount of power is indicated in the lower part of the panel shown in Figure 6.

In the discussion on transmission circuits for frequency modulation the procedure by which 12 telephone channels are packed closely into a frequency band of 48,000 cycles is shown. For transmission over coaxial cable, these standard 12-channel groups are used. Their further grouping

Figure 4. Plow train burying cable for coaxial-cable system

pack them into the coaxial cable is dicated in Figure 7. A standard super- roup of 60 channels is created by closely acking five of the 12-channel groups into 240-kilocycle band. This supergroup is anslated further into various parts of the equency range, as indicated in the figure, r transmission over the cable. Thus the 30 circuits occupy a range from 64 kilo- ycles to a little over two megacycles.

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* Subsequent to the writing of this article, a somewhat larger coaxial unit has been introduced which uses repeaters at about eight-mile intervals and main repeater stations up to about 150 miles apart.

The frequency range used with the same ystem for television transmission is some- hat different as shown in Figure 8. he phase-equalization requirements are o exacting for television transmission hat it becomes desirable to raise the ideo band by about 300 kilocycles, hus avoiding a very complicated equal- zation problem at frequencies lower than hat. On the other hand, the upper ange of the transmitted band can be ex- ended to about three megacycles without xceeding noise levels and other limits atisfactory for television transmission. he double-modulation process by which he video signal is raised into this range is ndicated in the figure.

The effective band width for trans- nission of television with the present quipment is 2.7 megacycles. This is less han the four-megacycle band which is the resent standard for television. It is, owever, a temporary situation and tests n 1941 over an 800-mile line indicated hat it gave satisfactory results for the tate of television at that time.

FUTURE DEVELOPMENTS

When the war suspended operations in his field, development work was under way on the design of a broader band coaxial system, making available at least four megacycles for television. One system that was under development will provide a band of seven megacycles or more. With this system it should be possible to provide for television whatever band is desired by the television industry, either four megacycles or more or less, and to use the rest of the band for multiplex telephone channels. With further advances in technique in the future, it is to be anticipated that a system permitting still broader bands over coaxial cables can be developed if desired.

Another promising looking method of providing for broad-band transmission systems for multiplex telephony and for television is the microwave-radio-relay system. This system carries over into radio technique one of the fundamentals of long-distance wire telephony, namely, the establishment of repeater points at frequent intervals along the circuit.

The Bell System has made arrangements for a development trial of a microwave-relay system between New York and Boston, Mass. Approval of the Federal Communications Commission already has been obtained for the project and work will proceed as soon as possible. For this trial seven intermediate relay repeater points will be used. Figure 9 shows the locations and heights of these intermediate repeater points. Height is important because the radio circuits will operate on visual paths. You will note that the maximum distance between repeater points is 35 miles and the average is about 30 miles.

The Federal Communications Commission has assigned to these experiments frequencies of about 2,000 megacycles, 4,000 megacycles, and 12,000 megacycles. This trial will be used as a method of determining practically the possibilities of this type of system in the present stage of development or, more exactly, in the state of development which can be brought about soon with intensive additional work.

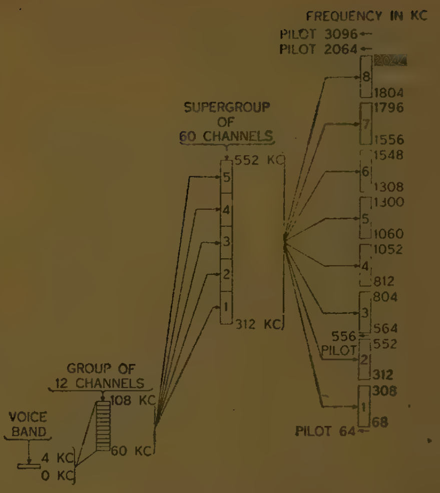

Figure 7. Frequency translation in carrier-telephone-terminal equipment for coaxial cable

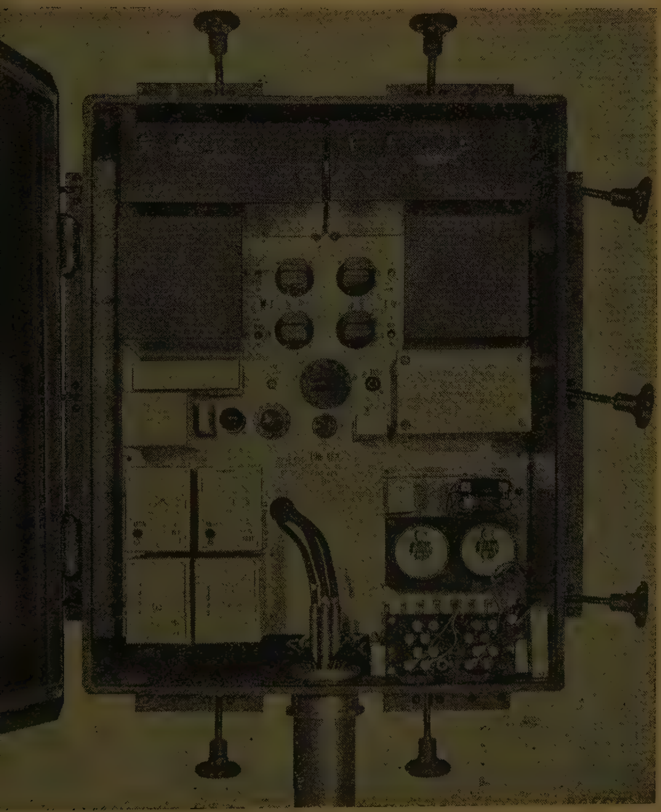

Figure 6. Equipment at coaxial repeater station

The development of a system of this type suitable for long-distance service involves the solution of many problems. While many of the elements which make up the system are already well developed, further extensive work will be required to organize them into a system suitable for this purpose. As in the case of wire circuits the individual repeaters must meet very exacting requirements in order that the cumulative effect of the transmission characteristics on a long-distance circuit will not exceed limits which are suitable for the over-all characteristics of such circuits. To meet such requirements it will be necessary to achieve in the ultra and superhigh-frequency ranges, where these systems are to operate, refinements in amplifier design. To do this doubtless will be the same kind of painstaking task that has been carried through in the development of amplifiers for the coaxial-cable systems operating at lower frequencies.

Moreover, many practical problems must be solved to provide a system of satisfactory reliability. Simple illustrations of this are the design of antenna supports having ample rigidity under storm conditions and the protection of the antennas from sleet and ice.

What the outcome of the experiments will be no one can say. We all look, however, with admiration at the great strides which were made during the war in the development of apparatus using ultrahigh and superhigh frequencies and it is the general expectation of radio engineers that, in the long run, such a system will be made practical. What its proper field of use will be in competition with other methods of transmission is, of course, as yet to be determined.

If the radio beams are found to have undesirable characteristics an alternative method of using superhigh frequencies is through the use of wave guides. These are simply hollow pipes which serve to isolate a little section of space and thus guide the transmission of extremely-high-frequency waves, and also to protect them from outside interferences. Such wave guides now are used extensively for short distances in ultrahigh-frequency work. Whether they will have a field for interurban transmission in competition with coaxial or repeatered radio remains for the future to determine.

PROGRAM OF THE BELL SYSTEM FOR THE CONSTRUCTION OF FACILITIES FOR VERY-BROAD-BAND TRANSMISSION

Where and when will the Bell System Companies have available intercity television-network circuits of the types just discussed? Here the situation is somewhat different from that for frequency-modulation networks as there is not a large network of suitable routes already established. However, such a network is being built rapidly as a part of the Bell System program for meeting additional requirements for long-distance telephone circuits.

A section of coaxial cable between Stevens Point, Wis. and Minneapolis, Minn., a distance of about 200 miles, has been in service since 1940. Coaxial cables have been installed between New York and Washington, D. C., Terre Haute and St. Louis, Atlanta, Ga., and Jacksonville, Fla. At the moment such cables are under construction between Atlanta and Meridian, Miss., and between Washington and Charlotte, N. C.

From a telephone standpoint the most important feature of this program is a second transcontinental cable route from Washington through Atlanta across the southern part of the country to Los Angeles, Calif. The completion of the entire route will be pushed as rapidly as possible. The company hopes that, in about a year, the cable will be in place at least as far west as Dallas, Tex. Other main features of this program are the connection of Washington and other Eastern Seaboard cities to Chicago and St. Louis to supplement existing cables and a new cable route from St. Louis south to New Orleans, La., intercepting the transcontinental route at Jackson, Miss.

While this plan no doubt will be modified in some details as it progresses, it is getting a big start in 1945 and it is expected that within about five years something substantially similar to this will be in operation providing long-distance telephone circuits. On these routes coaxial cable is the best method of providing the additional telephone circuits urgently needed to take care of growth.

Coaxial cable can be provided for all of this initial program. However, the radio-relay system will be used to any extent that may be found advantageous. The New York–Boston section is expected to consist of the experimental radio-relay system. The extent to which that system may be applicable to other sections of this initial network and to the additions which will follow in subsequent years cannot be predicted at this time. It is planned to use for each part of the network that type of system which is best, taking into account both service standards and economies.

It is anticipated that following the completion of this program, very-broad-band transmission facilities will continue to be placed on other routes as necessary to meet the service requirements of the telephone companies. This expanding network of very-broad-band transmission facilities will form an excellent basis for the development of nation-wide television-transmission networks when the art develops to such a point that these become desirable. Once a route is established additional requirements, either for telephone or television, can be established by the installation of additional equipment using in the case of cables, spare coaxial units provided to take care of future service requirements.

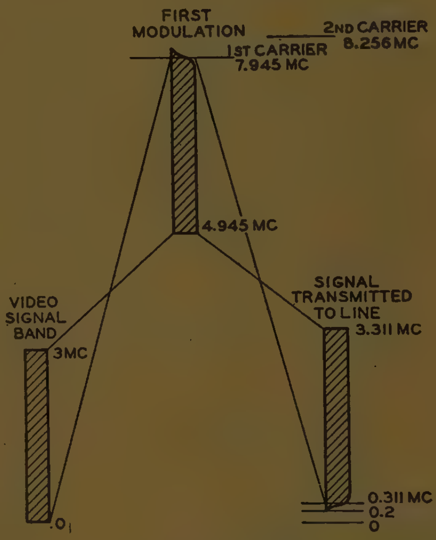

Figure 8. Frequency translations in television-terminal equipment for coaxial cable

NETWORK OPERATION

With the extensive development of frequency-modulation and television broadcasting, it is to be expected that transmission circuits of the types which have been described, or of other types which may be developed, will be connected to form great networks as is done now with the transmission circuits for standard-frequency broadcasting. The experience of the telephone companies in the operation of the present nation-wide networks shows that such operation involves many problems in addition to those of providing the circuits themselves. Much of this experience is indicative of the problems to be anticipated in the provision of networks for either frequency-modulation broadcasting or television. Therefore, a brief review of some of these problems is of interest.

Figure 10 shows the principal routes covered by the present program-transmission networks. A large part of the 135,000 miles of program circuit is associated with four nation-wide networks, but, in addition, there are a number of smaller networks. A single nation-wide network may connect 250 broadcasting stations with 20,000 miles of circuit.

Important features of network operation are the following:

1. To be suitable for network operation the transmission circuits must be kept at a very high level of maintenance. Interruptions or

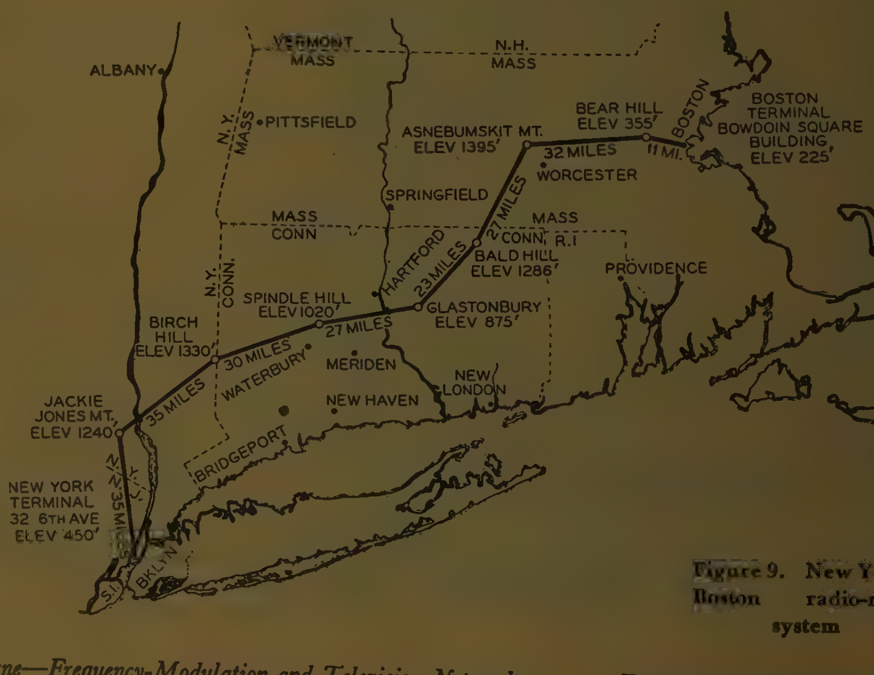

Figure 9. New York–Boston radio-relay system

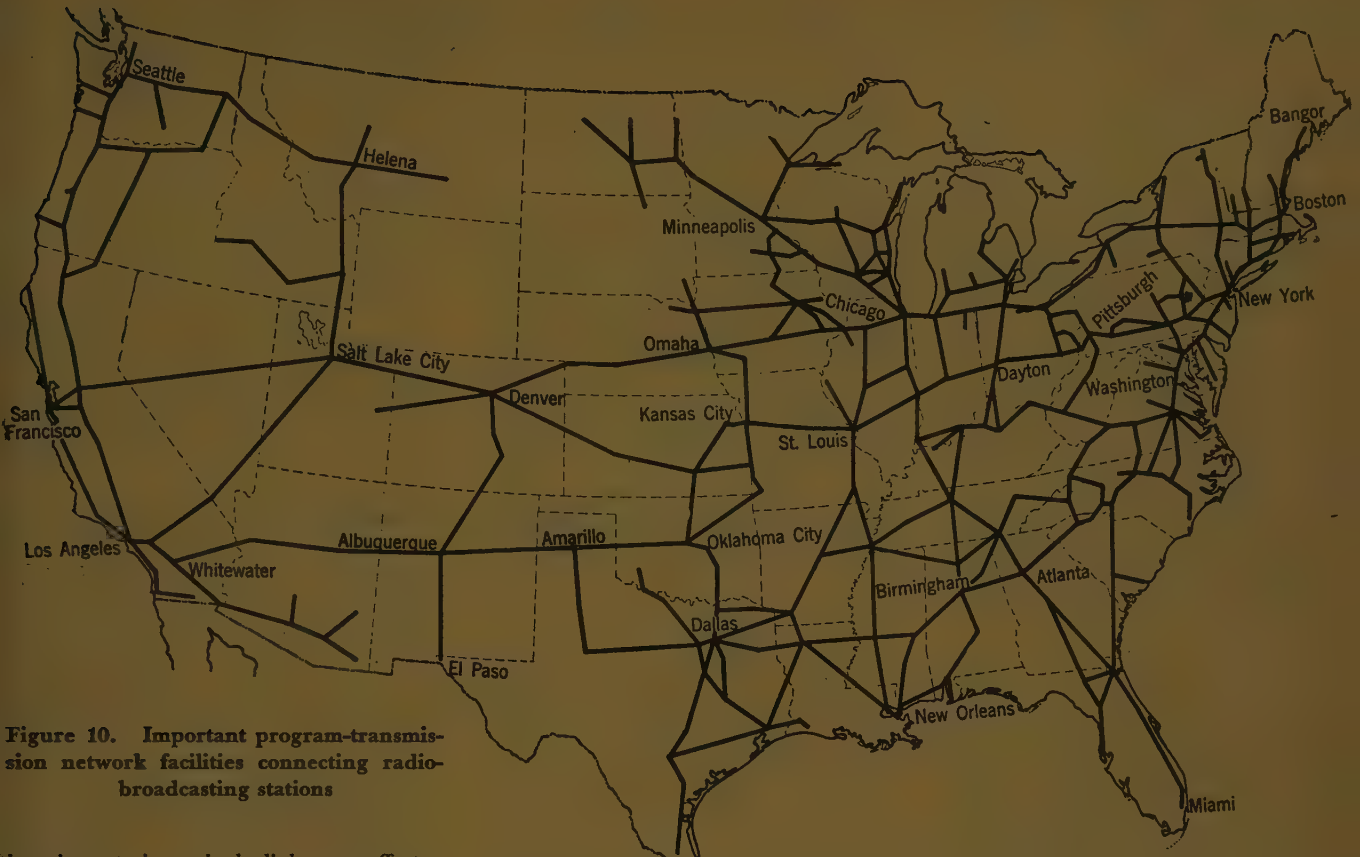

Figure 10. Important program-transmission network facilities connecting radio-broadcasting stations

impairments in a single link may affect a large part of the entire network. Whether a nation-wide network is made up of wire lines or radio-relay circuits or part of each, there is a great deal to be maintained. The coaxial cable involves cable and equipment all along the route and repeater stations, including equipment and sources of power at intervals of from 50 to 80 miles. The radio-relay system avoids the maintenance all along the route, but probably will involve repeater stations with sources of power and with their associated antenna structures at intervals of about 30 miles. In any case, a comprehensive and highly trained maintenance force is necessary for continued satisfactory operation.

2. The standards of design applied to each link of the network must be much more severe than would be necessary for the operation of the single link by itself. Each link must be designed so that it will work satisfactorily with many other links in a wide variety of connections. The distortion effects are cumulative and the maximum distortion between any two points of the network must be kept within satisfactory limits.

3. Throughout the country bridging equipment must be installed to enable the reception of a program over one link of a network and its transmission at that point to a number of others with proper transmission levels on each. One bridging point may supply as many as ten branches of a network.

4. Arrangements must be provided for instantaneous and often very complicated switching to rearrange the networks for successive programs. Much of this switching is done at the studios and a great deal is done at key points of the telephone system. In some places where the switching problem is complicated, arrangements are provided so that while one program is in progress the connection of the network for the next program is preset upon an alternative switching panel without interfering with the program. Upon the receipt of the proper cue, the attendant, by throwing a single remote-control key, instantaneously completes the rearrangement.

5. At key points attendants monitor the programs continually. Other attendants make a series of routine tests and make adjustments of level and other adjustments as necessary to insure the continued operation of the network. The amount of this work is equivalent to the full time of about 400 men. The total involved is, however, much larger, as many men spend only a part of their time on this type of work.

6. To assist this operating force in making their work most effective, key points are connected by a network of 70,000 miles of telegraph circuits devoted entirely to network operation.

7. At times of emergency the affected sections of network must be re-established in the briefest possible time by stand-by circuits and by spare equipment or by the use of alternative routes. At such times the existence of a large program-transmission network forming a part of a much larger telephone network is of great service importance. Numerous alternative routes are available and stand-by circuits and spare equipment are used in common to meet the needs of any individual network. Also, certain types of facilities designed for telephone-message service can be used.

This is a very sketchy outline of a number of diverse problems but it is sufficient to indicate that the operation of nation-wide television-transmission networks will involve a highly trained nation-wide organization and much equipment.

CONCLUSION

It is believed that the telephone companies can face any new requirement which may be laid on them by the development of frequency-modulation broadcasting and television with confidence because of their wide experience in handling nation-wide communication networks. The Bell Companies have in service 10,000,000 miles of long-distance telephone circuits terminating in 2,400 switching centers. They operate 135,000 miles of program-transmission circuits including the four nation-wide networks. These two services are incorporated in the same plant and handled by the same operating forces. The operation of these services provides a fund of experience which should be useful in the design, construction, maintenance, and operation of networks for either frequency-modulation or television transmission.

The telephone companies will be helped greatly in their efforts to give the best possible service to these new industries if they can take account of the prospective requirements for new transmission networks at the time they design broad-band extensions to the present great network of telephone lines. They, therefore, welcome from all who are interested in the application of these new arts information as to the development of their requirements and wish to receive these data as soon as possible.

A Reply From Industry to the Colleges

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Industry's evaluation of the responsibilities and contributions of education and some suggestions for its reconversion to a peacetime status are discussed in this article. It was written in response to a number of requests addressed to the authors by colleges seeking advice and criticism about proposed engineering curricula.

THE IMPORTANCE of engineering education to the future of industry in America was emphasized strikingly during the war years. Remarkable achievements in education paved the way for the miracles of industrial production that characterized World War II.

The colleges and universities of the country altered their programs to a remarkable degree to fit the requirements of the Armed Forces. In many instances these changes led to new and improved methods of teaching which readily can be applied to education for peacetime engineering.

THE JOB AHEAD

In the concern of the nation for the problems of reconversion of industry there is often little recognition of the significant reconversion job which the colleges face. We are particularly aware of its importance and magnitude because of our close contact with college graduates and our interest in education generally.

In recent months colleges have been asking the assistance of industry in planning postwar college curricula. Although few men in industry have ever taught in a college or university, many have had considerable contact with the college graduates who are hired annually by industrial concerns. Industry is rightly realizing the importance of education in engineering and welcomes an opportunity to discharge a part of its responsibility in this field by co-operating with the colleges in studying postwar curricula.

The Accelerated Schedule. There is grave danger that some colleges and the public generally may believe that an accelerated college program is superior to the prewar college schedule. Experience with those graduates employed in the last two years leads us to believe that the engineering graduate of an accelerated program is limited, compared with his prewar predecessor, in his ability to analyze engineering problems from fundamentals.

Students enter college much earlier than usual, with the result that few of them are sufficiently mature or emotionally adjusted for the college experience. Elimination of most free time in the accelerated schedule has reduced the effectiveness of instruction drastically. Those who advocate continuing the accelerated program fail to recognize the loss to the national culture and the lack of all-round ability of engineering graduates under such a program.

The Immediate Need. Some educators and industrial representatives will see in the reconversion facing the colleges an unusual opportunity to make sweeping changes. Although needed changes should be introduced wherever possible, we should recognize that the primary emphasis is upon the necessity of returning to basic college curricula as rapidly as possible. Except for men returning from the services, a negligible number of engineers will be available to industry in the next few years. Nothing should delay an immediate return to regular college programs in order that this barren period may be as brief as humanly possible. Any changes that are to be made, therefore, must not delay this return.

PRIMARY EMPHASES IN THE CURRICULUM

Basic Engineering Fundamentals. Engineering education in college must be concerned with engineering fundamentals rather than with specialized design. The war showed us that radically new designs usually must be based on the fundamentals of engineering rather than on previous design. It is far more important, therefore, for the college graduate to have a thorough understanding of all the fundamentals underlying engineering rather than detailed knowledge of any specific design or device. For example, a thorough understanding of such fundamentals as Newton's laws is of far more value in the solution of general mechanics problems than a host of specialized formulas.

Many will take exception to these beliefs, pointing out that widespread acceptance of them would lead to a single unified undergraduate engineering curriculum. At least one educational institution has done exactly that with success. In the authors' company, little recognition is ever taken of the branch of engineering in which a person was graduated, as the requirements of any electrical manufacturer so combine the mechanical, electrical, and chemical fields as to be almost inseparable.

The Case for Specialization. It has been argued in the past that the colleges must provide specialized training rather than fundamental understanding because many small companies do not have educational programs which will assist the graduate in obtaining practical experience. It is our belief that it is no more practical to graduate full-fledged engineers from college than practicing doctors from medical school. Perhaps because the materials with which the doctor deals are irreplaceable, we have recognized the importance of interneship earlier in this profession than in engineering. It is nonetheless essential to the successful training of outstanding engineers.

Some attempt has been made to recognize such an interneship or apprenticeship by the provision of some states, notably New York, for an "engineer-in-training" level of the professional engineers. Such an apprenticeship means that a small company without even a single good engineer who is capable of educating newer men cannot hope to supply this need directly from the colleges but must employ from some other concern an older engineer who has had both education and practical experience. In other words, there is no substitute for apprenticeship in the best sense of the word in engineering as well as in mechanical trades.

Stimulating Ingenuity. A second equally important consideration which must be borne in mind in discussing college curricula is the stimulation of the native ingenuity of undergraduates. During the war period, students usually were not encouraged to think for themselves in the rush of absorbing detailed knowledge in a rather limited field. We believe that emphasis on engineering fundamentals and ingenuity go hand in hand to develop a successful engineer. To encourage the ingenious student further, the curricula of the future should provide opportunity for the design and construction of ingenious electrical and mechanical devices.

The educational purpose will be better satisfied and more such projects can be

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Essential substance of an article endorsed by the committee on relations with industry of the Society for the Promotion of Engineering Education and published in the *Journal* of the SPEE and in *Mechanical Engineering*, August 1945.

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provided by the colleges if such devices are small and simple rather than large and complex. At least one college in the Southwest has scheduled this type of a lesign class with the additional condition hat only students who have demonstrated a certain minimum of ingenuity and who trongly desire to take such a class will be nrolled. Students in the past have often oeen required to take college design ourses regardless of their interest in lectrical design. Such design classes eldom have involved actual physical deign and development of ingenious deices. We believe that the plans for lasses such as that suggested will stimulate nterest in design and development to an nusual degree.

Extent of Electronics. It is hardly posible today to discuss engineering curricula without touching upon the subject f electronics. The special needs of the var stimulated an unusual interest in his subject. The need for technically rained personnel acquainted with elecronics principles resulted in the inclusion n most engineering curricula of a number f courses specifically designed to answer uch a need.

Although training in electronics during he prewar years was probably inadequate o meet industrial demands, the emphasis n education in electronics during the var exaggerated the relative importance f this phase of the electrical industry in he postwar period. In the authors' ompany, for example, estimates of postvar business indicate that the apparatus ines will still be ten times greater than he communications business. We therefore are vitally interested in maintaining proper ratio between education proided by the colleges along these two lirections.

In general, it is preferable to give the tudent engineer a broad concept of the omplete frequency spectrum, emphasizng particularly the fundamentals underying the operation of devices at any requency. Thus, whenever need arises or a fundamental understanding of highrequency problems, the basic principles re already well understood. In addition o presenting proper technical material, he college also must be prepared to stress he relative importance of communications ompared with the other branches of ngineering.

Preparation for Citizenship. Many aricles have appeared in the technical ress in recent months emphasizing the nportance of the nontechnical portion of n engineering undergraduate curriculum. here is no doubt that recognition of the nore cultural and liberal phases of eduation too long has been ignored in engieering colleges. Here also, however, here is some reason to advocate caution n the extent to which the nontechnical art is increased. It is beyond question hat some engineers adequately prepared echnically have found great difficulty in adjusting themselves to industry and developing an active participation in society and community life as a result of their lack of understanding and appreciation of nonengineering subjects. Great care must be experienced in the way in which such subjects are taught if maximum benefit is to be derived. In his book "On Education,"* Sir Richard Livingstone is particularly emphatic concerning the periods in a person's life when such material can be absorbed most usefully:

> "That is, you cannot study fruitfully liberal subjects, among them philosophy and politics, unless you know something of life. On the other hand, there are subjects, such as mathematics, which a boy or undergraduate is fully capable of understanding, even if he knows nothing outside the walls of his home, school, or university. For whereas politics and ethics are concrete, mathematics is purely abstract and theoretic and does not spring from life or need experience of life to illuminate or correct it."

We believe that the principal purpose of such subjects as English, public speaking, and art of dealing with others, in engineering curricula should be to acquaint the undergraduate with the importance of these subjects and to develop his appreciation for them as essential to his future career even as an engineer. Too often in the past an attempt has been made to get across a certain minimum of information rather than an attitude of mind. All of these liberal subjects should be taught by a person who has a sincere appreciation for the role of the engineer in society and who can understand fully the engineering point of view. It is only such leadership that can stimulate and impress the young engineering student with the importance and value of such liberal material.

For example, much of the student's antipathy for English can be traced, we believe, to a lack of understanding of the engineering student by his English professor. This point is illustrated particularly well in a recent article[1] by A. M. Buchan. This same article describes the effect of encouraging the professor of liberal subjects to appreciate the relation of engineering to society in these words:

> "The professors learn from their students. An interest in technical subjects has been born, and the old literary bias against them is disappearing. A notion of culture as an attitude assumed toward any subject, technical or philosophical, rather than as familiarity with certain arts and books begins to appear, and the teacher of Wordsworth or Thoreau finds himself engaged, and happily, in discussing baking methods or the development of alloys. For the teacher of speech, too, there can be a realization that the orderly description of a coke oven is just as valuable practice as an argument on Fascism."

We also would suggest that, in spite of the modern tendency to depreciate the value of foreign languages in the curricula, there is a real value in the study and mastery of languages other than our own. The study of history, economics, and civics should not be neglected, but in these also emphasis should be placed upon developing an attitude of mind in the student which will make him aware of the engineer's responsibility as a member of society and the large part which he should play in such society.

ADULT EDUCATION FOR ENGINEERING GRADUATES

Recognition of the importance of adult education has increased greatly in the past few years. A quotation from Sir Richard Livingstone mentioned earlier suggests that intensive study of cultural or liberal subjects, such as philosophy and politics, is properly postponed beyond graduation and should be reserved for a later period in the engineer's life when he has had some experience outside the school. There has been a strong tendency for the college graduate to consider his education completed.

The proper attitude toward education as a process of continual growth should be stressed again and again to the undergraduate. He then will recognize that without education there can be no growth, and without growth of individuals there can be no progress. Rarely has a graduation address failed to dwell on this aspect of education. Yet much of the student's previous conditioning in college creates an opposite attitude. The Engineering Council for Professional Development has recognized the need of engineers for adult education, particularly in liberal subjects, and has strongly supported the demand for adequate adult education.

What Has Been Done. In Denmark, "high schools" have been established to provide liberal education for adults. What has been accomplished in this field in this instance is described by Sir Richard Livingstone.

> "...the Danish People's High School, should be of peculiar interest to us for it is the only great successful experiment in educating the masses of a nation. It has reached the very classes for which we have done little or nothing. It has taught them to care for subjects like history and literature which seem remote from the man in the street. It has transformed the country economically, given it a spiritual unity, and produced perhaps the only educated democracy in the world. Here is that rare thing in education—an ideal embodied in fact. It is curious that it has excited comparatively little attention among ourselves who are facing the problem which these Danish schools have solved.
>
> "We find it difficult to think of Denmark as a poverty-stricken country lacking in energy or enterprise; but such it was in the early nineteenth century, and its transformation into one of the most progressive and prosperous democracies of Europe was largely the work of the education given in these schools. . . ."

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* Quoted by permission of the publishers, the Macmillan Company, New York, N. Y.

A New Area of Engineering Education. We believe that the colleges and universities of the country should take the lead in providing adequate opportunities for education in liberal subjects for engineering graduates. In many cases this may involve considerable rearrangement of schedules and programs to accommodate evening classes. The teachers of these classes also will benefit greatly because, for the first time, they will have students whose "experience of life" is fully as great as their own. The class members thus will contribute much to the instruction of the class. The value to the nation and to the individual adult student far outweighs the difficulties which must be overcome to provide such opportunities.

THE MOST IMPORTANT FACTOR IN EDUCATION

Although revision of engineering curricula is a laudable undertaking, it is almost useless to consider such changes apart from the teaching staff. The failure to stress the significance of outstanding teachers in college education is to neglect the most important factor in education. No opportunity should be overlooked to attract outstanding engineers to the teaching profession.

The question has often been raised as to whether there is a wide difference in salary levels between industry and education which deters a young man from considering a career in education. The problem is well illustrated by a recent comment by Dean C. J. Freund of the University of Detroit:

> "There are such (ideal professors) but most colleges cannot afford them. It has been my experience that after an outstanding teacher has been developed, he will someday be a luncheon or dinner companion of the president of a manufacturing or industrial corporation. He impresses the president who very soon thereafter offers the professor or assistant professor a salary which is fabulous according to college standards. The professor may be an idealist and he may be devoted to his university, but there are limits even to generosity and heroism."

The Contribution of a Great Teacher. Many schools undoubtedly never would be able to employ a full complement of outstanding teachers at adequate salaries. Such schools would find it profitable to make use of undergraduate leaders, selected for their brilliance and teaching ability, in order to obtain maximum benefit from the really few born teachers which the college could hire.

> "A great teacher is a man whose personality is so attractive and whose character is so fine that by unconscious tuition he wins the admiration and lifelong devotion of his students and all unconsciously influences their ideals and molds their characters so that they are forever after better men for having sat under him. There is no substitute for the inspiration and guidance which such a man can contribute."[2]

Wherever there are great men, there is so often a great teacher behind them. There is nothing more important than teaching. There are many outstanding teachers in the colleges now; their numbers must be increased. We must have the best and most capable men in the nation guiding the education of youth.

LEADERSHIP—A PRESSING NEED

No discussion of college education would be complete without mention of leadership. America long has been noted for its educational system, in particular, for the high level of the average intelligence of its citizens. In our desire to improve the average intelligence, we have more and more neglected the brilliant individuals. We must recognize that the contributions to society of an Edison, Marconi, or Alexanderson are far greater than those of scores of John Does. Without depreciating the necessity for mass education, we must in the future concentrate on developing an equally good system for educating the outstanding individuals.

We have great interest in the proposal that undergraduate leaders be selected to assist the regular professors. These carefully selected young leaders, if given proper freedom, could do a much better job of stimulating the students than some of the present instructors who remain on the college pay rolls without promotion for several years. The average pupil thus simply would go through the classes in the present manner, the outstanding student would get the extra opportunity, responsibility, and incentive of teaching a younger class. In addition, the substitution of these undergraduate leaders for regular instructors would release sufficient funds to hire a few really brilliant outstanding professors. Such men would be required to have the ability of working closely with the undergraduate leaders, stimulating and inspiring them, yet making each responsible for his class.

THE AIMS OF EDUCATION

There are then these principal goals toward which the colleges should continue to strive: A stronger emphasis on broad engineering fundamentals; an appreciation of the role of the engineer in society for all college students; and the creation of leadership of a high order. The degree to which we can attain these objectives will determine the future of engineering and of all America.

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Unorthodox Deck-Edge Elevators in Service

The United States Navy hurled its carrier-based bombers and fighters against the Japanese by means of a unique "deck-edge" elevator that whisks planes up the outside of the ship to the flight deck in a matter of seconds. This was revealed recently by the Westinghouse Electric Corporation. Now being installed on the Navy's new fleet of "Midway"-class supercarriers, the unorthodox new elevators secretly have been in battle service in every major task-force operation in the Pacific.

The deck-edge elevator speeds battle action aboard the carriers because it enables plane-handling crews to keep the central-flight deck cleared of incoming planes as fast as they land. As the 50-ton platform is to one side of the flight strip, landed planes can be whisked aside, out of the flight area, with a minimum of handling. During take-offs, too, it permits faster delivery of planes from the hangar deck and prevents planes awaiting take-off from "bunching up" around the elevator openings, as they did when only the bow- and stern-deck elevators were available for delivery from below.

Thirty-four feet wide and 60 feet long, the platform is hung "outboard" over the sea at the edge of the flight deck, opposite the carrier's superstructure. This platform is built of welded pipe and, in use, carries a towing tractor and the handling crew. Because the carriers themselves were designed to permit passage through the locks of the Panama Canal, the 34-foot wide elevator platform is mounted so it will fold up and not strike the side of the canal locks. The platform is lifted and lowered by means of eight $1^{1}/_{8}$-inch steel cables which pass over a series of direction-changing and leverage-multiplying sheaves, or pulleys, and are finally attached to either end of a huge hydraulic piston and cylinder assembly, which is the simple "engine" of the system. The piston of the engine is activated by oil pressure led into the cylinder from a pair of compression tanks, where two 150-horsepower electric motors, operating variable-stroke pumps, maintain oil pressure at a constant 850 pounds per square inch. As only part of this pressure is required for a single trip of the elevator from the hangar to the flight deck, the 300-horsepower total power available from the pump motors is the maximum power drain on the ship's electric system at any one time for the operation of the elevator. The use of oil under pressure also enables the elevator to make one complete round trip on "stored" energy even if the motors and controls are put out of action. Thus, if damage occurs while the elevator is loaded, its planes can be brought to the hangar deck, and the elevator returned to the flight-deck level.

Statistical Methods in Quality Control

VI. Charts for Go-and-No-Go Inspection

A method of analyzing the results of go-and-no-go inspection in order to judge whether or not the best results are being obtained on a given job is presented in this article.

STATISTICAL METHODS for control of quality of manufactured products are applied effectively and easily in analysis of test results from go-and-no-go inspection. The purpose of this kind of inspection is to determine whether or not individual units of product meet engineering tolerances, that is, merely whether they are good enough to pass. Generally, no further information about the quality characteristics is sought in this type of inspection.

The results from go-and-no-go inspection may be analyzed best by control-chart technique, the steps in which analysis are:

1. Tabulate for a reasonable time the number of units of product inspected each hour, or each day, the number rejected in each period, and the fraction defective for each period (see Table I).

2. Plot changes in fraction defective from hour to hour, or day to day, in chronological order on a control chart (see Figure 1).

3. Judge by means of control limits whether such changes as occur in hourly, or daily, fraction defective reasonably may be expected to be the result of chance alone (see Figure 1).

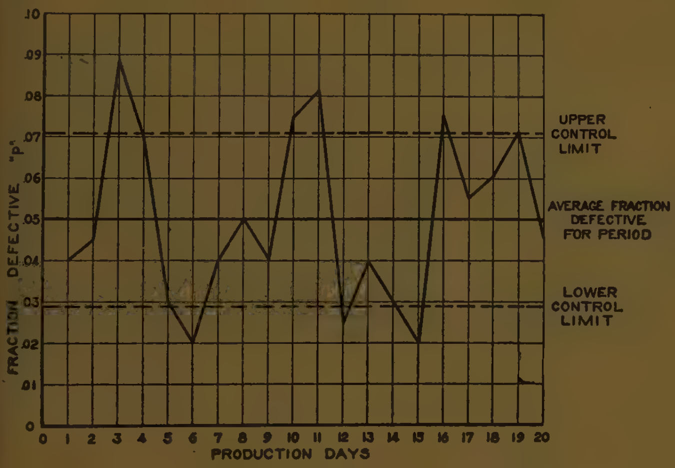

Figure 1. Control chart for fraction defective p constructed from data in Table I

The methods of carrying through these three steps are discussed in the following in connection with the inspection of motor end shields.

In any mass-production job, inspection stations are set up at the critical points in the manufacturing process: on certain important parts, at subassembly, and at final assembly. At these inspection stations, units which fail to meet specified requirements are rejected. To inspect should mean more than just sifting the good units from the bad; data regarding the fraction defective at such inspection stations are an index of quality and, by applying statistical methods to these data, conclusions can be drawn as to how well the job is controlled.

On a certain operation (machining a motor end shield) the average fraction defective over a period of 20 days was 0.05. The question then came up, "Is this the best we can do with our present method of machining the motor end shield?" This question can be answered definitely through proper analysis of the variations in the "fraction defective" during each of the 20 days. Control-chart methods will indicate how much variation is likely to occur because of chance (that is, when there are no definite troubles or difficulties). By this means we can tell whether this job is as good as can be expected.

Definite control limits (within which the daily fraction-defective results should vary if there are no definite troubles affecting the job) first are established. If the variations in fraction defective are within these limit lines, we can say that we are getting the best results or, in other words, that the job is under control. If variations are beyond the limits, we are not getting the best results; the job is out of contr

In the case of the motor-end-shield jo during 20 days there were 1,000 (or fi per cent) defective units in a total produ tion of 20,000 units. The actual dai results are indicated on the control cha (Figure 1). We want to know what vari tion in the daily per cent defective can allowed and therefore proceed as follow

1. The average fraction defective duri the 20-day period was 0.05 (which will designated as p).

2. The formula for control limits on t fraction defective is

$$p \pm 3\sqrt{\frac{p(1-p)}{n}}$$

(here n is the average daily production)

3. Substituting our values for the en shield job, we have control limits

$$= 0.05 \pm 3\sqrt{\frac{0.05(0.95)}{1{,}000}}$$

$$= 0.05 \pm 3(0.0069)$$

$$= 0.071 \text{ and } 0.029$$

Our control limits thus are 0.071 a 0.029, which correspond to 7.1 per ce and 2.9 per cent defective.

As several points fell above and bel the limit lines, we know that we shou have better results than we are gettin On the days when the fraction defecti was 0.089, 0.075, 0.081, and 0.075, the must have been a factor which was n present on other days. If that troub could be identified and corrected, could obtain a lower fraction defective.

Table I. Data on Inspection of E Shields

Day	Number Units Inspected	Number Defective	Fracti Defect
1	1,005	40	0.040
2	1,000	45	0.045
3	1,015	90	0.089
4	995	70	0.070
5	1,000	30	0.030
6	985	20	0.020
7	990	40	0.040
8	1,010	50	0.050
9	1,000	40	0.040
10	1,005	75	0.075
11	990	80	0.081
12	995	25	0.025
13	1,010	40	0.040
14	1,000	30	0.030
15	1,000	20	0.020
16	1,005	75	0.075
17	1,005	55	0.055
18	995	60	0.060
19	990	70	0.071
20	1,010	45	0.045
	20,000	1,000	0.050

* Fraction defective above upper control limit.

One of a series of articles prepared in the AIEE subcommittee on educational activities and sponsored by the AIEE subcommittee on statistical methods.

Personnel of the AIEE subcommittee on educational activities: J. Manuele, H. F. Dodge, A. I. Peterson, and R. E. Wareham.

The advantage of using the limit lines was that we could tell definitely how much variation should be allowed instead of judging by opinions and guesswork. If all the points fell within the limit lines, then we would have known that we were getting the best possible results from that process and that further improvement could be made only by changing the design or production methods.

In other words, limit lines offer an index of control. We know that it is practical to hold the fraction defective within these limit lines. Therefore, if the fraction defective is more than the limits allow, we are sure that we can do a better job. On the other hand, if our actual fraction defective is within the limits, we know that we are controlling our operations well and, therefore, we can not expect to get fewer defects unless we change the design of the part or the method of making it. Thus quality-control methods can be of real help in answering the old question, "Are the rejections on this job as low as we can make them?"

When we have made such an analysis and find that the job is out of control, the next step is to segregate the defects by the operations which cause them. Defects in the following operations: machining the rabbet diameter, machining the rabbet face, and boring the bearing hole are known to be the chief causes of trouble with these end shields. Analysis of the fraction defectives from each of these causes will tell us which operation is out of line. (This analysis may be made as outlined in a previous article of this series.[1]) A study of the particular operation will indicate the reason for the high percentage of defectives and point to correction of the trouble.

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Selective Service in World War II

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A brief summary of the organization and accomplishments of the Selective Service System in World War II which registered and classified more than 45,000,000 men is presented in this article.

NO AGENCY of the United States Government has ever affected as many men or the destinies of as many families as the present Selective Service System which came into existence following the passage of the Selective Training and Service Act of 1940. Conceived in peace, it soon became an agency responsible for the rationing of the manpower of a country at war, required on the one hand to furnish to the Armed Forces the number of men necessary for final victory and, on the other hand, to leave in the mines, factories, on the farms and railroads, those men necessary to supply the implements of war, to feed and clothe both the Armed Forces and those at home; all to be accomplished with the least possible disruption of family ties.

ORGANIZATION

The successful operation of this gigantic task undoubtedly has been due to a policy of decentralization. The 6,443 local draft boards in the United States and Territories each were composed of three or more local citizens, working without pay as a patriotic service. On these men fell the real work of classification and selection for military service. A state headquarters for Selective Service supervised the work of the local boards within each state, under the administration of a state director appointed by recommendation of the governor.

The national headquarters of the Selective Service System was concerned primarily with policy and over-all guidance. It revised the regulations as necessitated by revisions in the law, such as the Tydings' Amendment making mandatory the deferment of registrants engaged in essential agriculture, and by changes in policy, such as the drafting of fathers. It dealt with the state directors and made reports to the Congress as requested. The director of Selective Service was responsible directly to the President, except during a period in 1943 when Selective Service was under the War Manpower Commission. Boards of appeal were established in each state with jurisdiction over specified areas. Decisions of these boards on matters of classification were final, except for cases subject to further appeal to the President. (Figure 1 shows organization.)

PROCESSING OF REGISTRANTS

By August 1, 1945, over 9,600,000 men had been inducted into the Armed Forces through Selective Service. The number sent to the Armed Forces, however, gives only a faint indication of the work performed by local boards, appeal boards, and other agencies of the Selective Service System. This is best illustrated by the fact that over 76,000,000 classification actions have been made in the course of processing and reprocessing registrants of military age. Over 31,000,000 men under 45 years of age were registered and classified by local boards, and an additional 14,200,000 aged 45–65 were registered.

Appeals to state appeal boards, which amounted to about 83,000 prior to the war, totaled over 4,500,000 during the period December 1, 1941, to August 1, 1945. An amendment to the Selective Training and Service Act in December 1943, requiring that all occupational deferments be reviewed by the appeal board having jurisdiction over the area of principal place of employment, increased the work of appeal boards sixfold.

The operation of the Selective Service System required the combined efforts of approximately 200,000 unpaid and paid personnel in the United States and Ter-

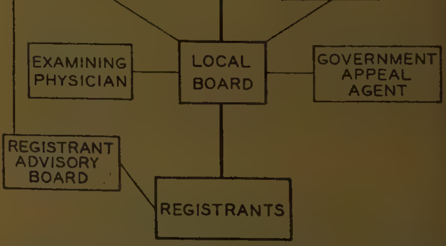

Figure 1. Elements of the Selective Service System

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ritories. Included in this number were 24,000 members of the 6,443 local boards, 15,000 re-employment committeemen, 36,000 examining physicians and dentists, 96,000 members of appeal and advisory boards, and 8,000 appeal agents, all working without compensation. The remaining 21,000 were paid full-time or part-time employees.

Some idea of the cost of operating the Selective Service System may be obtained from the financial obligations for the year ending June 30, 1944, which totaled over $65,000,000. The two largest items in this total were $32,000,000 for personal service of local boards (clerks) and $15,000,000 for transportation of selectees.

As data for the planning and operation of the system needed to be furnished on each of 6,443 widely separated local boards and also to each board and state, the greater part of the statistical program was devoted to reporting activities. Problems of accuracy, comparability, flexibility, and promptness resulted in a decision to develop a system of individual punch card records on each registrant, to have these cards available at national headquarters, and to produce such data from them as were required both routinely and specially for the entire system. Data to keep the cards currently correct were obtained from detailed reports forwarded by local boards immediately after each board meeting.

Equal to the reporting work in importance, though not in magnitude, was the analytical part of the statistical program. This phase was concerned with the development of estimates and the accomplishment of research. Examples of the former include the predetermination of the date when it would become necessary to induct fathers (October 1, 1943) and estimated yields for induction from various age groups of the manpower pool. Among the more valuable results of research studies were the Medical Statistics Bulletins and reports on defects of rejected registrants.

The research reports were obtained largely from sample studies. In this work, four different types were used:

1. A one-per-cent sample of each local board.
2. A sample of each state.
3. A ten-state sample (100 per cent for each of these states).
4. A two-per-cent (125 local boards) sample.

The first type of sample was used to determine the status of registration groups a year after their registration. The sample consisted of every 100th registrant in each local board. Samples of each state were used in the preparation of medical statistics. The ten-state and two-per-cent (125 local boards) samples were used for studies on age and classification. The 125 local boards compose a stratified sample, selected geographically from urban and rural areas, checked as a whole for representativeness with national totals.

One example of the data obtained from the two-per-cent (125 local boards) sample is shown in Figure 2. This clearly indicates the effort on the part of the local boards to induct the younger registrants and defer for essential work those more advanced in age and experience.

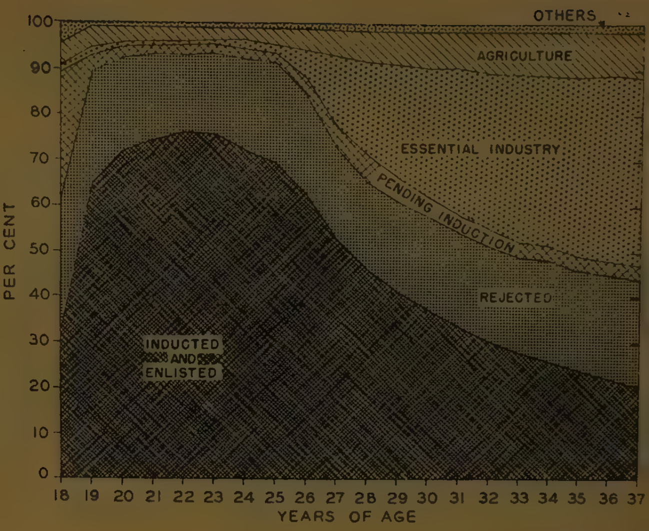

Figure 2. Classification of registrants ages 18 through 37 by individual year of age as of March 1, 1945

No attempt was made to accumulate the vast amount of information from the Selective Service questionnaires which were filled out by all registrants of military age. These data were required only by local boards for purposes of classification, hence the expense of compilation could not be assumed by the Selective Service System. This information, if compiled by states, would be of great sociological value.

CONCLUSIONS

The Selective Training and Service Act of 1940, as amended, followed very closely the final form of Selective Service in World War I. Both authorized "selective draft" for the Armed Forces from citizens aged 18–45 for the period of emergency; forbade bounties, substitutes, and purchased exemption; exempted outright only ministers, divinity students, and high public officials; exempted conscientious objectors from combatant service; and authorized exemptions at Presidential discretion for essential occupations and dependency. Both established the state as the unit for quota allotments; authorized local boards and appeal boards.

The United States is fortunate that the Congress passed its first peacetime conscription law in 1940 instead of waiting until that fateful day of December 7, 1941. When the country awoke to find itself engaged in a global war, the Selective Service System was in full operation.

The successful operation of Selective Service in two world wars has been due largely to the fact that the programs were instituted in time, at the beginning or prior to the outbreak of hostilities. The obligation of service was personal and nontransferable, and no group received favoritism. If mistakes were made, they were in full view of the community, as all classification and selection for induction or deferment was made locally by the registrants' neighbors. The armies indeed were raised by the civilians at home.

Use of Electron Microscope in Dust Study

To the versatile electron microscope has been added another function: the determination of the size, distribution, and shape of infinitesimal particles of dust and pollen in the air. A subject of considerable interest to the air-cleaning industries, the study of these particles has been limited by the magnifying power of the light microscope, which can give information on particles above five microns in size only.

But the electron microscope, with its magnification of up to 50,000 diameters, can recognize particles as small as 0.005 micron, and can determine the form of those 0.02 micron or larger. Such studies are being made in the research laboratories, Westinghouse Electric Corporation, East Pittsburgh, Pa., on dust, smoke, and pollen.

Because the electron microscope can penetrate matter to a depth of only 0.01 to 0.05 micron, the specimens must be collected on an extremely thin film of collodion or other plastic material. This in turn is mounted on a 200-mesh stainless-steel screen $^1/_8$ inch in diameter. Tobacco-smoke particles can be collected by holding the film and screen in a trail of smoke for a few seconds. Dust can be gathered by making the specimen the negative and a fine point the positive electrode.

With this microscope not only can the nature of the foreign material in the air be studied, but also the efficiency of the air-cleaning process itself can be evaluated.

Electricity, Life, and Sensation

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With several of the historical physiological investigations as a basis, this article presents a discussion of the electrical characteristics and activity of living matter, particularly of nerves and the connection between stimulus and sensation.

FROM THE STUDY of physical surroundings, the curiosity of some investigators turns inward on men themselves. *What is life? What is man?* These philosophical questions have challenged thinkers of all ages along with questions as to the nature and purpose of the world. Now, equipped with concepts and apparatus much more powerful and precise than those of previous investigators, scientists are attempting to correlate physical measurements with physiological and psychical activity of living organisms, with hunger, emotions, sensation, thought, and so forth.

Because modern electric detecting instruments are very sensitive and because electric stimuli can be controlled accurately, investigations of the electrical characteristics of living tissues have been extensive. These investigations have shown that the maintenance of electric potential differences and a sensitivity to electric stimuli are two universal characteristics of living matter, plant or animal. The potential differences and the sensitivity disappear as life disappears. A potato or a horse will have a potential difference of 10 to 100 millivolts (about a hundredth to a tenth the voltage of a flashlight battery) between the inside and outside of its tissues while living. By so little a potential difference is life evidenced and maintained.

Furthermore, all sensory or motor impulses in nerves are accompanied by volleys of pulses of electric potential variation, pulses of constant magnitude traveling down the nerve at speeds of 10 to 100 miles per hour.

To appreciate the truth-seeking research underlying these generalizations and to understand their significance, let us review briefly some of the historic investigations of the electrical characteristics and activity of living matter, particularly of nerves. See how keen logic and improved apparatus became the tools of man's curiosity in uncovering some laws of his own being and activity.

Let us throw ourselves as much as possible into the confused state of mind of early investigators. Do you believe in "animal magnetism"? Do you believe in "animal electricity"? Magnetism is as respectable a physical phenomenon, in this year of 1786, as is electricity. Why should animal magnetism be any less probable than animal electricity? This is an age of scientific miracles—Benjamin Franklin with his kite drawing electricity out of the skies. Who knows what these men with insatiable curiosity may discover next?

Luigi Galvani, an anatomist and physiologist by profession and professor at the Institute at Bologna, believed in the existence of animal electricity. Perhaps he reasoned something like this. Joseph Duverny back in 1700 noted that the limbs of a frog are convulsed by an electric discharge. And certainly since the development of the Leyden jar in 1745 many a careless experimenter can testify to the fact that his nerves and muscles were stimulated by an electric discharge. If living tissues are sensitive to electricity, must they not partake of the nature of electricity? (Newton, in England, showed that bodies acted on by the force of gravity themselves possess mass, the property of matter from which the gravitational force seems to arise.) Similarly, animals may themselves contain electricity since they are susceptible to its influence.

After experiments on the effects of external electric discharges in producing muscular contractions, Galvani tried to demonstrate the presence of electricity within the muscle itself. In 1786 he hung the freshly skinned legs of a frog by a copper hook through the spinal cord and noted vigorous contraction of the frog's legs when they touched the iron stand to which the copper hook was fastened. Later experiments showed that contractions took place whenever metallic connection was made between spinal cord and leg muscle. To explain the contractions Galvani assumed that the muscle contained animal electricity and acted as a Leyden jar with outer surface negative and inner surface positive. The leg nerve was considered to be the conductor of the Leyden jar; it supplied the muscle with electricity, presumably from the central nervous system. The discharge of the muscular Leyden jar caused contractions of the leg. Galvani's experiments were published in 1791 and aroused great scientific and popular interest. The frogs fared badly.

Alessandro Volta, professor of physics at Pavia, Italy, at first accepted Galvani's results, but in the course of his investigations observed that, except in favorable circumstances, contractions could be produced only by touching the frog with rods of different metals. He then advanced the opinion that the muscular contractions were caused by electricity generated from touching the limb with dissimilar metals. This was the beginning of a long controversy between Galvani and Volta.

Galvani extended his researches to meet Volta's objections, obtaining contractions merely by touching nerve to muscle with no metal present. This experiment might have been convincing had he not attempted to explain away entirely the generation of electricity by contact of dissimilar metals. Volta in his turn piled up experiments to prove the generation of electricity by two heterogeneous metals in a moist conducting medium. His views prevailed, especially when death called Galvani from the field of controversy in 1798 and when Volta developed the voltaic battery in 1799.

In reality Galvani had stumbled upon a complex phenomenon involving both animal electricity and electrolytic generation of electricity, and both he and Volta had overstepped their scientific observations in asserting the existence of a single action. An "either–or" theory was too simple (as it so often is) to explain the observed events. The great German naturalist Alexander Humboldt perceived this, pointed out the limited applicability of Volta's experiments, and published some researches establishing quite con-

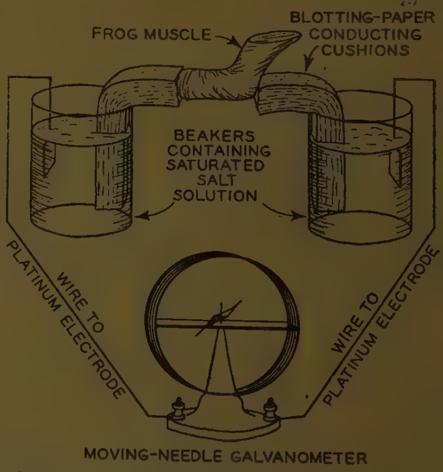
FROG MUSCLE
BLOTTING-PAPER CONDUCTING CUSHIONS
BEAKERS CONTAINING SATURATED SALT SOLUTION
WIRE TO PLATINUM ELECTRODE
WIRE TO PLATINUM ELECTRODE
MOVING-NEEDLE GALVANOMETER

Figure 1. Typical setup for du Bois-Reymond's experiments with animal electricity

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Essential substance of an article published in the June 1945 issue of the *Northwestern Engineer*, a student publication of Northwestern University.

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clusively the existence of animal electricity. In spite of this and some writings by Aldini, Galvani's nephew, the existence of animal electricity was discredited and practically disappeared from scientific investigation until 1827.

Investigations into the current electricity generated by the voltaic cell monopolized electrical experiments after 1800, and the concept of an electric circuit became fundamental. Oersted discovered the magnetic effect of current in 1820, and Schweigger developed a moving needle galvanometer two months later. Also in 1820 Ampere discovered the force on a wire carrying current in a magnetic field. Ohm's law was published in 1825, and Faraday's discovery of electromagnetic induction came in 1831. The development of these new concepts and apparatus influenced the study of animal electricity greatly.

The invention of the galvanometer provided the means whereby investigations of animal electricity were once more brought to the fore. In 1827 a French investigator Nobili devised a very sensitive galvanometer and demonstrated the electromagnetic effect of the "frog current" as it came to be known. Nobili placed the spinal cord and feet of a frog in separate vessels containing brine or water. When the circuit between the two vessels was completed through a galvanometer, the frog's muscles contracted and might continue to give a current for several hours. The deflection of the galvanometer needle indicated a positive current passing from muscle to nerve, or feet to head, in a frog.

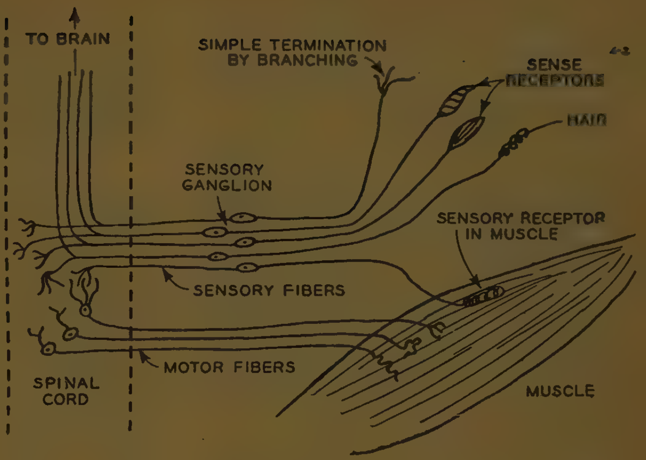
An Italian, Matteucci, demonstrated that current from the lower to the upper part of a frog leg could be obtained with all nerves removed. This discovery overthrew the Voltaic doctrine of electrolytic action between nerve and muscle and upset Nobili's thermoelectric theory based on differential rates of cooling between nerve and muscle tissues. Matteucci also constructed weak batteries of frog hearts and pigeon thighs. His work laid the basis for the investigations of Emil du Bois-Reymond a great German physiologist (1818–96) who quite properly may be called the father of the science of electrophysiology.

The questions which du Bois-Reymond tried to answer were: what are the laws describing correctly the actions of animal electricity, and what is the origin of animal electricity? The existence of a phenomenon having been demonstrated, the problems of describing its manifestations and finding the causes of its existence were next to be approached.

How could animal currents be measured? By means of a galvanometer. Nobili had noted that frog muscles often contracted when his galvanometer needle showed no deflection. So du Bois-Reymond constructed more sensitive galvanometers.

How were the galvanometer leads to be connected to the frog tissues? The effects of small currents caused by slight dissimilarity of the electrodes must be avoided. Platinum electrodes carefully cleaned and heated to incandescence were attached to the galvanometer leads and dipped in saturated salt solutions in separate vessels. Cushions of blotting paper, each with one end dipping in the salt solution and the other over the edge of one vessel, were used as electrodes to connect to the muscle or nerve being studied. To protect the frog tissues against the corrosive action of the salt solution, the conducting cushions were covered with a guard of pig's bladder moistened with the white of an egg. In a typical experiment the conducting vessels with their platinum plates were connected into a closed circuit through the galvanometer to make sure that no voltaic action was present at the electrodes. Then the conducting cushions were separated and a muscle or nerve placed between them. The experimental setup is illustrated in Figure 1.

Figure 2. Diagrammatic representation of a nerve and its connections



This circuit arrangement and experimental procedure are described in some detail because the technique developed by du Bois-Reymond became the standard for later investigators, and they illustrate some of the niceties which must be introduced in experiments on animal electricity to avoid erroneous results.

What is the general law of muscular currents? Du Bois-Reymond discovered that if a muscle were cut in two and the cut or transverse section placed on one conducting cushion and the uninjured muscle sheath, or longitudinal section, on the other, a comparatively strong current was set up in the galvanometer. The current was directed from the transverse section (cut surface) of the muscle to the longitudinal section (sheath) *within the muscle*. This direction proved the same for all animals. Du Bois-Reymond in 1843 formulated the law for muscular currents as the antagonism of the transverse and longitudinal sections, the cross section of the muscle acting as the negative and the outside of the muscle as the positive terminal of a battery. The experiments on tissue currents later were refined to show that the same law held for the individual fibers of which the muscle was composed.

Because of the greatly increased sensitivity of his galvanometer over those of previous investigators, du Bois-Reymond was able to detect a small electric current in nerves also, and this current was directed similarly to that in muscles, that is, in such a direction as to indicate that the cut section was negative with respect to the sheath of the nerve.

So much for the "resting currents" of muscles and nerves. What are the conditions under which an electric current could stimulate living tissues? Du Bois-Reymond extended the investigations of previous experimenters, using as stimuli induction shocks and constant currents let into the muscle or nerve by electrodes applied at different points. Either the muscle or its nerve could be excited. When a constant current was used to stimulate the leg nerve, muscular contraction took place at make and break of the circuit but did not continue all the time the current was flowing. This, together with the fact that contractions appeared more vigorous if the current were made to rise or decline more rapidly, led du Bois-Reymond to announce this law of electric excitation:

> "The motor nerve is not excited by the absolute density of the current, but by the variations of this amount from one instant to another, and the excitation caused by these changes is the greater the more rapidly the changes take place, or the greater they are in any given time."

He carefully pointed out that this law applies strictly to motor nerves only. Sensory nerves are affected by a steady current. Thus taste nerves give a continuous sensation as current is passed through the tongue and a continuous hum is produced by a constant current flowing into the ear.

Following the basic experiments of du Bois-Reymond, there was a great deal of research into animal electricity during the second half of the 19th century. Let us summarize a few of the outstanding discoveries with regard to the electrical activity of nerves and see what understanding they may give into the nature of sensation.

Nerve cells, called neurons, possess all the structural characteristics of a typical cell (semipermeable cell wall, foam-structured cytoplasm, and central nucleus), but their shape and detailed organization have been modified to suit their primary functions of receiving stimuli and transmitting impulses. From the nucleated cell body extend long fibers, or processes. The cell bodies of neurons are located near the spinal cord, and each cell has one long fiber extending from that location out to the part of the body which it serves. Neurons are classed into two functional groups, sensory and motor neurons, according to whether they normally transmit nerve impulses from the body tissues toward the spinal cord or whether they act conversely.

A nerve is a sheathed bundle of many individual nerve fibers, both motor and sensory fibers existing in one nerve. (The sciatic or leg nerve of a frog contains over 3,000 fibers.) The fundamental structural features of nerves are illustrated in Figure 2.[1] Specialized developments of the nerve endings give rise to receptor organs particularly sensitive to certain types of stimuli.

Many investigators studied the conditions under which a nerve was excited by electric stimuli. They touched two electrodes to a nerve and sent various types of electric currents between the electrodes; constant currents, single induction pulses, repeated pulses, and so forth. Electric currents have been used as stimuli in nearly all studies of the excitability of nerves, for the currents do not injure the nerve and they can be measured easily, graded in intensity, adjusted in duration, modified in wave form, and repeated exactly and rapidly. Their use in studying the normal behavior of nerves has been justified by the theory that the response of a nerve is the same whatever may be the particular type of stimulus which excites it, a theory which has been well substantiated. For example, a sensation of light may be produced by a light on the retina, by a blow on the head, or by passage of an electric current through the eyeball.

It was discovered that a nerve possesses a definite threshold for a given type of stimulus, such that stimuli weaker than the threshold value fail to excite the nerve. A certain minimal rate of change of stimulus is also necessary, though du Bois-Reymond exceeded the bounds of scientific caution and exactitude when he stated that excitation of motor nerves depended on this factor alone and not on the current density. Duration of a stimulus is another factor; a strong stimulus can give rise to excitation in a shorter time than a weak stimulus. It was discovered also that following initiation of a response in a nerve there is a short insensitive or refractory period, a few thousandths of a second, before a new stimulus will initiate a new response. There is also an inverse phenomenon of summation in which two subthreshold stimuli applied in quick succession may

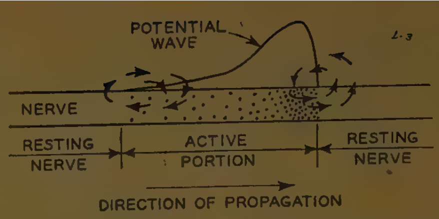


Figure 3. Local currents at active portion of nerve

initiate a response. The sensitivity of a nerve decreases as the excised tissue dies, is decreased by anesthetics, and is affected by temperature variations. These are the primary discoveries regarding the excitability of nerves.

Now what of the second characteristic activity of nerve fibers, the transmission of nervous impulses? Apparently a wave of negative potential variation sweeps down a nerve fiber as an impulse travels along it, for two electrodes placed on a nerve fiber can pick up the potential differences as the impulse travels by. The potential differences may be amplified and recorded accurately by means of various types of galvanometers, electrometers, and oscillographs. The potential waves may be detected whatever type of stimulus is used to excite the nerve; they do not depend on electric stimuli.

Early experiments proved that impulses may be conducted in either direction along either type of nerve fiber. Measurements of the time lag between the initiation of a nerve impulse at one point and its reception at another point indicated the following rates of conduction of nerve impulses: 8 meters per second for nerves of smooth muscles in mammals, 6 to 12 meters per second in the claw nerve of the lobster, 27 meters per second for the motor nerves of a frog at room temperature, and 25 to 200 meters per second in various motor and sensory nerves of man. The low rate compared to the velocity of light upset old ideas that nervous impulses were simply electrical impulses conducted along nerve fibers as cables. It made a chemical form of propagation seem more likely.

Conductivity of nerves is lost at death and is weakened or destroyed by various anesthetics. Rate of conduction rises with temperature. This temperature dependence, quite similar to that of many chemical reactions, suggests once again the probability that chemical alterations are the underlying physical phenomenon.

On the basis of such evidence as that indicated in the foregoing the German physiologist Hermann suggested an electrochemical theory to explain the phenomena of excitability and conduction in living tissues, postulating that electrochemical reactions at the stimulating electrodes gave rise to chemical effects which propagate themselves along tissues. Hering, German physiologist and psychologist at the University of Leipzig, extended the theory by relating the chemical effects to physiological processes of tissue construction and destruction. The commonly accepted theory today, the membrane theory, may be regarded to have developed from the electrochemical theory of Hermann and Hering.

According to the modern theory the cell membranes of living tissues act as a semipermeable "ionic sieve" which maintains a higher concentration of negative ions in their interior than in the surroundings. Thus the inside of the tissues becomes electronegative with respect to the surrounding medium, and a layer of positive ions may collect on the outside of the tissue walls, making a sort of condenser arrangement of the membrane. This is the state of dynamic ionic equilibrium when the cell is at rest; the potential gradient across the cell membranes promotes nutritive chemical reactions which maintain the protoplasm of the cells and keep the cell walls semipermeable.

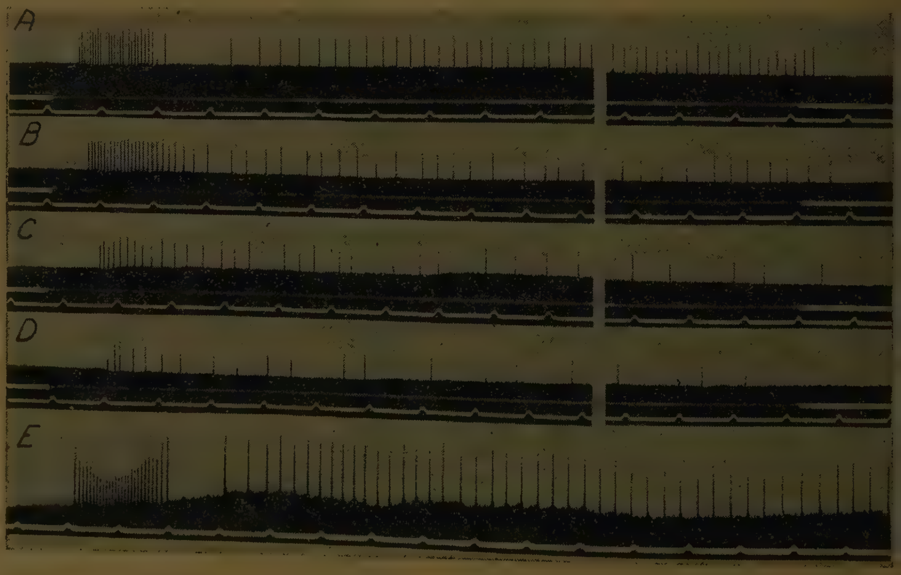


Figure 4. Action potentials of a single nerve fiber in the optic nerve of a horseshoe crab

When the concentration of positive ions outside the cell wall is destroyed, it is thought that the "depolarizing action," if sufficiently great, changes the chemical activity of the protoplasm in such a way that the cell wall becomes unstable, loses its semipermeability, and permits eruption of the negative ions from within the cell. This efflux of negative ions constitutes excitation; it accounts for the negativity which appears in an active region of tissue and for the wave of negative potential variation which is associated with the nerve impulse.

The ion flow does two things:

1. It excites adjacent regions of the tissue.
2. It brings about a state of insensitivity (refractory state) in the active regions.

The action is illustrated by a diagram from R. S. Lillie,[2] professor of physiology at the University of Chicago, which is shown in Figure 3. A wave of negative potential difference is progressing down a nerve to the right. The relative magnitudes of the negative potentials (with respect to resting nerve sheath) are indicated for points in the active region. Local currents flow from the resting nerve to the excited region (or negative ions from active to resting regions). This flow stimulates the nerve on ahead of the excited portion. Of course, local currents circulate behind the negative portion also, but the failure of these to set up excitation may be accounted for as a result of the more gradual potential slope of the latter portion of the negative wave or on the assumption that portions of the nerve which have just undergone stimulation are less than normally excitable. The net result is that the nerve impulse propagates down the nerve to the right by an electrochemical transmission of the excited portion along the nerve.

By means of the improved apparatus for detecting and recording small, quick potential variations, the electric wave accompanying the nerve impulse has been "mapped" accurately during the present century. It is a sharp, short, "spike" type of wave. As a nerve impulse passes under a detecting electrode placed on a single nerve fiber, the potential rises to a maximum of perhaps a millivolt in 0.005 second and then falls nearly to zero in three times that long, though the final decline is very gradual and zero may not be reached for 0.010 second. Pictures of these spike potential waves may be seen in Figure 4. The spike part of the impulse seems to be the characteristic nerve reaction necessary for the transmission of messages. The height of the spike varies with the physiological state of the nerve fiber but not with the type or magnitude of the stimulus which initiated the nerve impulse. Final proof of this fact came in 1926 when E. D. Adrian and Y. Zotterman, physiologists at Trinity College, Cambridge, England, succeeded in recording photographically the potential waves resulting from exciting a single sensory nerve fiber. Appreciation of this fact is vital to an understanding of the action of nerves. The nerve impulse is an activity of the living nerve tissue and not a purely physical effect of the stimulus. The energy of propagation for the impulse is derived from the nerve itself and not from the stimulus. Indeed, the transmission of the nerve impulse often has been compared with the firing of a train of gunpowder, where the energy of transmission is derived locally from the combustion of successive portions of the train.

But this proposition, that nerves exhibit an all-or-none type of response, raises some interesting questions. Hermann back in the 1860's noted that the magnitude of the muscular contraction of a frog leg increased as the strength of the current exciting its nerve was increased, at least until a maximal contraction was reached. Such an effect might be caused, however, by an increasing response in each nerve fiber or by an increase in the number of nerve fibers excited by the stronger currents. That the latter hypothesis is the correct one was demonstrated quite conclusively by Keith Lucas in 1909.

Lucas, a brilliant English investigator and fellow at Trinity College, Cambridge, combined keen insight, manipulative skill, and cautious scientific judgment. His classic and beautifully reported experiment dealt with contraction of the skeletal muscle fiber.[3] It had been shown that the nerve supplying the small cutaneous dorsi muscle of the frog contained only nine or ten individual nerve fibers. Lucas reasoned that if this nerve were stimulated by gradually increasing strengths of current, the muscle contractions would substantiate one or the other of the above hypotheses. If the increase in muscular contraction were gradual, an increase of the magnitude of the nervous impulse in each fiber would be indicated. But if the magnitude of contraction increased in discontinuous jumps as the stimulus increased continuously, an all-or-none type of muscle response would be indicated, with the muscular contraction depending solely on the number of active fibers.

Lucas fixed one end of the muscle to a stationary support and attached the other end to a lever bearing a mirror. A light beam reflected from the mirror was photographed and gave a magnified picture of the muscular contraction. The nerve was stimulated by an induction shock whose strength was increased by gradually approaching the secondary to the primary coil. The graphs of magnitude of muscular contraction as a function of distance between the induction coils showed that the muscular contraction rose to its maximum in a number of definite steps which was always less than the number of nerve fibers. Apparently each nerve fiber stimulated certain muscle fibers, and once a given nerve fiber was excited by the stimulus, all the muscle fibers which it served were stimulated to maximal contraction.

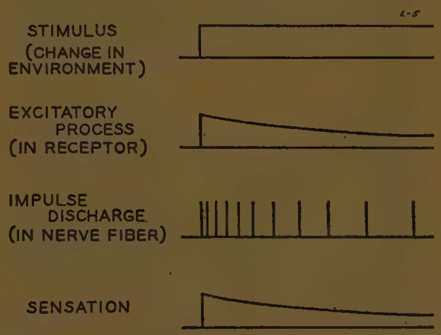


Figure 5. Relation between stimulus, sensory message, and sensation

Though Lucas carefully pointed out that the all-or-none characteristic of the muscular contraction could not certainly be referred back to the nerve-fiber impulses themselves, his experiment added plausibility to the theory of all-or-none action in the nerve fibers.

However, a further question remains. Graduations of sensation, say of light or of sound intensity, seem to be continuous. Certainly the number of levels of light and sound intensity which can be discriminated exceeds the number of fibers in the optic or auditory nerve. How can this be possible if each nerve fiber, once stimulated, gives a maximum response?

The answer to this question was long foreshadowed, but the final verification of the true hypothesis was thrilling and conclusive. Du Bois-Reymond had noted that sensory nerves gave continued response to a constant current stimulation, instead of separate, short responses at make and break of the current as did muscles and motor nerves. Later investigators discovered that muscles and motor nerves might respond to very strong shocks by a tetanic contraction or by a series of impulses. Apparently a muscle or nerve after responding to a stimulus in its characteristic way becomes incapable of further excitation for a short (refractory) period, and then recovers excitability. A strong or continued stimulus may then initiate a new response. This repeated excitation of a muscle or motor nerve by a strong stimulus does not continue for long, because the tissue apparently adapts quickly to the changed environment of the stimulus and ceases to give further response. But sensory nerves, or their end organs, seem not to adjust quickly to a changed environment so that they send out a continued volley of nerve impulses in response to a continued stimulus. The stronger the stimulus the shorter will be the time interval between successive impulses, for a stronger stimulus can initiate a new impulse earlier in the refractory period as the nerve (or end organ) gradually regains its excitability. Thus stronger stimuli send higher frequency volleys of nerve impulses down a sensory nerve. Information regarding the magnitude of sensory stimuli is carried to the brain by frequency modulation of a train of nerve impulses in the sensory fibers.

The experiment of Hartline and Graham on the eye of a horseshoe crab was an exciting and clear demonstration of the correctness of the foregoing hypothesis. These two American physiologists, working under grant from the Johnson Foundation, succeeded in 1932 in obtaining the first records from a single optic nerve fiber. The logic of the experimenters and the wonderfully adequate technique of the investigation leave little to be desired.

The excised eye and optic nerve of the horseshoe crab were placed in a moist chamber with the surface of the eye protruding from a small window. The nerve was slung across two threads soaked in sea water, which served as recording electrodes for the moving reed oscillograph used to record the potential variations from the optic nerve. The variable intensity light which provided the stimuli in the experiment came from an electric lamp through a small diaphragm and was focused on the eye by means of a microscope.

To yield the pulses from a single nerve fiber, the optic nerve was floated in sea water and teased apart with a fine glass needle. The isolated bunches of nerve fibers remaining then were tested and further dissected until the electric response to illumination showed only a single series of impulses. Records obtained in this manner are shown in the photographic strips of Figure 4.[4] The records from *A* to *D* show the electric responses in the optic nerve as the stimulating light intensity was decreased in steps, 0.1, 0.01, 0.001, and 0.0001 arbitrary units respectively. The gaps in the records indicate intervals of several seconds in each case. Record *E* shows the effect of high frequency of response (intense stimulus) on the height of the potential spikes during the initial outburst of activity.

After the initial outburst the height of the individual pulses is constant (about 0.3 millivolt), proving the all-or-none activity of the nerve. Only the frequency of the pulses changes with the intensity of the stimulus. The variation of frequency with intensity of stimulation shows approximately the logarithmic relation predicted by the Weber–Fechner law of sensation. The maximum frequency observed was 130 impulses per second. (In human auditory nerves frequencies up to 1,000 per second have been detected.)

So it is with other sensory nerves. Sensations of sound, touch, pain, and heat apparently are conveyed to the brain as a series of nerve impulses of constant height whose frequency varies with the intensity of the stimulus. The impulses traveling in different types of sensory nerves apparently are similar, so that the brain must distinguish different sensations by identifying the nerve fibers sending in messages rather than from any peculiarity of the message received.

The detailed activity of the brain in interpreting sensory nerve impulses is not known as yet. One estimate of its behavior, however, might be made. The nerve impulses are abrupt, discrete variations, while sensation seems to be a gradual continuous phenomenon. We might guess, then, that the brain acts in some way to integrate the rapid volleys of discharges from the sensory nerves, much as would a galvanometer of long period when rapid pulses are sent through it.

On the basis of this guess our present knowledge of the links between stimulus and sensation might be pictured as shown in Figure 5, taken from E. D. Adrian's "The Basis of Sensation."[1] The sudden, constant change in the environment (stimulus) produces excitation in the sensory end organs, but the excitability decreases more or less gradually as the end organs accommodate to the changed environment. The changing excitability of the end organ is transmitted by the sensory nerve as a series of pulses whose frequency varies with the reaction of the sensory receptor. The brain integrates the pulses from the sensory nerve to obtain a sensation which is a more or less faithful reproduction of the stimulus according to the fidelity of response in all parts of the system involved.

So the study of nerves and sense organs enables us to make a little better guess as to the answer to the question: what is sensation? As Adrian says,

> "It does not bridge the gap between stimulus and sensation, but at least it shows that the gap is a little narrower than it was before."

REFERENCES

1. The Basis of Sensation (book), **E. D. Adrian.** W. W. Norton and Company, Inc., New York, N. Y., 1928.

2. Protoplasmic Action and Nervous Action (book), **R. S. Lillie.** University of Chicago Press, Chicago, Ill., 1923.

3. The "All-or-None" Contraction of the Amphibian Skeletal Muscle, **Keith Lucas.** *Journal of Physiology*, volume 38, 1909, page 113.

4. Nerve Impulses From Single Receptors in the Eye, **H. K. Hartline, C. H. Graham.** *Journal of Cellular and Comparative Physiology*, volume 1, 1932, page 277.

Speeding Repairs on Fighting Craft

Disclosure of how electric equipment, supplied on a rush basis by seven major plants of the General Electric Company, Schenectady, N. Y., operates in the Navy's advance-base section docks to speed repairs on fighting craft ranging from small vessels to battleships, has been sanctioned by the United States Navy. The mammoth floating dry docks recently were announced by the Navy as in strategic locations in the Pacific. Each of the sectional docks is literally a combined floating factory unit and hotel in itself, since each has its own repair equipment, power-generating, distribution, and power-utilization equipment, pumps, windlasses, compressors, and ventilating and refrigerating units, as well as full facilities for accommodating a crew of 40.

An elaborate system of motor-operated valves and powerful pumps driven by 200-horsepower vertical motors submerge and raise these docks, and capstans operated by 30-horsepower motors warp the damaged vessels into them. Remote-operated level indicators in a control house, showing the level of the water in the various ballast chambers, assist the dock master to direct these operations over an intercommunicating system to operators stationed at control panels in each section.

The docks are equipped to supply the vessel under repair with both a-c and d-c service. Alternating current is derived from a bus fed by generators rated 438 kva, two of which with the necessary switchgear and related equipment are located in each section. The d-c service is obtained from a 300-kw 250/125-volt three-wire sealed ignitron rectifier. The power-generating equipment is unique in that it is designed so that when a ten-section dock is used for repairing a battleship, thus requiring all 20 438-kva generators to be operated in parallel, current-limiting reactors are connected to limit short-circuit currents.

In addition to the major electric equipment, each section is equipped with one 1-horsepower and three 5-horsepower fresh-water pump motors with full voltage starters; one $7^1/_2$-horsepower salt-water circulating pump motor; one 3-horsepower ventilating-fan motor; and a number of other motors of various sizes for refrigerating, compressor, anchor windlass, sewage disposal, and fire-fighting purposes. Each dock also has two electrically driven revolving jib cranes, both of which are protected by crane-stability gauges.

Other than being selected with the view to meeting the rigorous conditions imposed by dry-dock service, much of the electric equipment is, but for minor modifications, of standard design. The metal enclosed switchgear for controlling the generators, however, was custom-made for the application, with the power output connected to a specially designed distributing system. Also, the 10-, 25-, and 50-kva transformers for ship service, lighting, and heating circuits, respectively, as well as the 300-kw rectifiers for supplying d-c service, were required to be designed to withstand mechanically the 90-degree tilting of the wing walls of the docks. This tilting takes place when the wing walls are folded flat to the decks of the sections to facilitate towing the docks from one location to another.

INSTITUTE ACTIVITIES

New Frontiers of the Profession to Be Explored at the Winter Convention

The AIEE winter convention will be held at headquarters in the Engineering Societies Building, 33 West 39th Street, New York, N. Y., January 21–25, 1945. Both the winter-convention committee and the technical-program committee have met and the ground work has been laid to restore the convention with its prewar features, insofar as possible, including the dinner–dance, smoker, and inspection trips. The advantages of these social features with opportunities to renew old acquaintances and good fellowship long have been recognized. The technical program will be almost as broad as the whole range of Institute technical-committee activities.

TECHNICAL PROGRAM

Technical sessions and conferences will provide a series of papers with an approach to the new frontiers of the profession. Many papers will be based on wartime developments which heretofore have been restricted. A conference on education will explore the borderline relationships between physicists and engineers, which may lead to suggestions for changes in curricula. Plans are in prospect by the committee on basic sciences for a possible conference on atomic energy. One of the proposed technical sessions will deal with radar tubes and circuits, provided restrictions are lifted sufficiently to make such a session worth while. Many other papers will treat electronic applications, particularly in the fields of power, industry, and communication. Detailed arrangements are proceeding along the foregoing lines, which altogether promise an interesting, timely, and valuable technical program.

HOTEL ACCOMMODATIONS

The hotel situation in the metropolitan area is acute and quite likely will remain so for some time. Members, therefore, are urged to make their plans early and arrange for accommodations directly with the hotel preferred. The Institute has no connections with any of the hotels and cannot undertake to make reservations.

Members Urged to Place "Supplement" Orders Early

Members desiring the December 1945 *Supplement to Electrical Engineering—Transactions Section* are urged to place their orders before December 15, 1945, to insure obtaining their copies upon publication. Members with standing orders, however, need make no further reservation; upon notification to Institute headquarters, a standing order may be arranged at any time.

This supplement to *Electrical Engineering* will contain technical papers and discussions not published in the monthly issues. Its price is 50 cents to members and it may be ordered from the AIEE Order Department, 33 West 39th Street, New York 18, N. Y. Further details of the supplement's contents and availability will be announced in this section in a subsequent issue.

AIEE Organizes New Planning Subcommittees

Two new subcommittees of the AIEE committee on planning and co-ordination have been appointed to study problems of growing urgency both in the Institute's relations with the engineering profession and with the more highly specialized organization and trends within its own general field. These subcommittees, known as the technical-activities subcommittee and the professional-activities subcommittee, will carry the major burden of fact finding, weighing of evidence, and preparation of recommendations, and thus will render an important service not only to members of the Institute but also to the engineering profession and to society.

The duties of the subcommittees will include a review of the organization, methods of operation, and scope of the technical activities of the Institute and of other engineering and scientific societies. On this basis the technical-activities subcommittee may recommend changes that "the advancement of the theory and practice of electrical engineering and of the allied arts and sciences" may be pursued more effectively and the professional-activities subcommittee may prepare recommendations for changes in organization and improvements in method for the "maintenance of a high professional standing among its (the Institute's) members" and among members of the engineering profession as a whole.

These objectives are to be accomplished by a maximum of co-operation and a minimum of duplication of effort as between the Institute and other organizations and by affording an opportunity for active participation by more individuals. The subcommittees also will recommend changes necessary to render the structure and procedures of the Institute sufficiently flexible and adaptable to take account of progress in the art and the development of new fields of interest and to respond promptly to changing social, political, economic, or other conditions affecting the welfare of society and of engineers.

All members of the Institute are invited to offer constructive suggestions or to express their opinions as to what is lacking in the way of services which should be available to members. Communications may be addressed to Institute headquarters, to

M. D. Hooven, chairman
AIEE Technical-Activities Subcommittee
Public Service Electric and Gas Company
80 Park Place
Newark 1, N. J.

or to

T. B. LeClair, chairman
AIEE Professional-Activities Subcommittee
Commonwealth Edison Company
72 West Adams Street
Chicago 90, Ill.

Additional Officers and Committees Announced

In order to facilitate the work of the AIEE protective-devices committee, the following subcommittees, with attendant personnel, have been formed for 1945–46:

Circuit Breakers and Assembled Switchgear

H. J. Lingal, *chairman*
A. E. Anderson
H. W. Collins
William Deans
H. W. Haberl
J. R. North
H. V. Nye
M. S. Oldacre

Switches, Fuses, and Insulators

H. H. Rudd, *chairman*
H. D. Braley
O. E. Charlton
F. R. Ford
A. H. Powell
H. L. Rawlins
G. V. Smith
J. C. Woods

Lightning Protective Devices

W. J. Rudge, *chairman*
E. W. Beck
F. M. Defandorf
T. H. Mawson
W. E. Rushlow
A. H. Schirmer
H. R. Stewart
E. R. Whitehead

Fault-Current Limiting Devices

F. R. Longley, *chairman*
J. E. Clem
G. B. Dodds
R. D. Evans
E. T. B. Gross
P. A. Jeanen
H. P. St. Clair

Relays

W. A. Lewis, *chairman*
J. C. Bowman
W. R. Brownlee
G. B. Dodds
E. L. Harder
L. F. Kennedy
E. W. Knapp
S. C. Leyland
W. E. Marter
E. L. Michelson
J. H. Oliver
C. E. Parks
H. R. Paxson
F. C. Poage
J. H. Vivian
C. A. Woods

The following additional appointments to the AIEE board of examiners also have been announced:

R. W. Atkinson
Robin Beach
C. R. Beardsley
C. M. Gilt
J. J. Pilliod
H. H. Weber

A complete list of the officers and committees for 1945–46 appears in *Electrical Engineering*, September 1945, pages 339–43.

Members of Standards Committee Appointed

Supplementing the list of AIEE officers and committees for 1945–46 which was published previously (*EE, Sept '45, p 339–43*) the following names are added as members of the Standards committee. These appointees for the administrative year beginning August 1, 1945, are the following:

R. L. Jones, *vice-chairman*
R. C. Bergvall
J. E. Clem
C. M. Gilt
R. T. Henry
T. B. Holliday
Alexander Maxwell
A. C. Monteith
S. H. Mortensen
J. R. North
M. S. Oldacre
E. B. Paxton
F. B. Silsbee
G. Thompson

Future AIEE Meetings

Winter Convention
New York, N. Y., January 21–25, 1946

South West District Meeting
San Antonio, Tex., April 16–18, 1946

North Eastern District Meeting
Buffalo, N. Y., April 24–25, 1946

Southern District Meeting
May 13–16, 1946.

Summer Convention
Detroit, Mich., June 24–28, 1946

Pacific Coast Convention
Seattle, Wash., August 26–30, 1946

DISTRICT • • • • • •

North West District Executive Committee Meets

The 1945–46 meeting of the North West District (9) executive committee was held in Spokane, Wash., September 28, 1945. G. K. Haspel (M '31) dial telephone engineer, plant department, British Columbia Telephone Company, Vancouver, British Columbia, Canada, was present to attend the discussion on Section operation and management.

A. V. Eastman (M '40), E. W. Schilling (A '29, F '44), and W. E. Enns (A '37, M '44) were appointed judges for the District prize-paper competition. J. F. Gogins (A '40) was selected to represent the North West District on the nominating committee.

The meeting concluded with a four-hour conference on Section operation and management.

The Seattle Section will continue with its plan for holding the Pacific Coast convention in Seattle in August 1946.

District Conferences on Section Operation

Since the usual delegates meetings were not held during the current year because of the cancellation of the summer technical meeting due to the war emergency, District conferences on Section operation and management have been developed by the Sections committee. These are to serve as a substitute program for the benefit of the incoming Section officers, and to help maintain the high level of interest of all Section officers in Section operation and management.

The conferences are being conducted by the District vice-presidents, and arrangements have been made for the Sections committee representative located in each District to attend his respective conference, and materially aid with the discussions. In several Districts, a plan is under way for the host city to hold a meeting of the Section on the evening of the District meeting so that the Section representatives attending the conference will have a further opportunity to increase the number of personal contacts among the members of the Section in that city.

No conference is to be held in New York City District (3), as this District comprises only one Section. At the request of Canada District (10), arrangements were made for the District officers and officers of the Montreal and Toronto Sections to attend District (1) meeting and for the Section officers of the District (9) meeting.

The first of these series of meetings was held in North Eastern District (1) at Schenectady, N. Y., June 13, 1945, with Vice-President R. T. Henry (A '24, F '33) presiding.

Turrets each mounting a pair of 50-caliber machine guns were used in a first public demonstration on the Pacific coast of the B-29 remote-control turret system at the June 19, 1945, meeting of the AIEE Seattle Section. The system permits gunners to pass control of the turrets from one to another, and to train the fire of several turrets on a single target. The equipment, shown from left to right, is the upper rear turret, power units and computer (in the background), ring sighting station, upper forward turret (with two guns installed instead of four), and nose sighting station. The men from left to right: Lloyd Shackelford, (A '42) service engineer General Electric Company, who demonstrated the system; F. T. Parker (A '42) service engineering department, General Electric Company, and Harry Stavert, Boeing Aircraft Company.

SECTION • • • • •

Subsection in Lake Charles, La.

After considerable preliminary work the executive committee of the AIEE New Orleans, La., Section authorized the formation of a Subsection in the Lake Charles area which formally came into existence March 16, 1945. The area allotted to this Subsection includes the parishes of Beauregard, Allen, Calcasieu, Jefferson Davis, Acadia, Lafayette, St. Martin, Cameron, Vermillion, Iberia, and St. Mary.

Financial assistance, to aid in organizing, has been extended Lake Charles by the New Orleans Section and plans are being formulated whereby operating revenues will be allotted proportionally to the new Subsection. B. H. Bell (A '22, M '43) chairman, New Orleans Section, has extended an invitation to all members of the Subsection to attend functions of the Section whenever possible.

Officers elected are as follows: A. D. Hargroder (A '43) chairman; G. V. Cooper (A '43) secretary treasurer; B. A. Fleshman (M '44) meetings and program chairman; F. I. Stalnecker (A '39) membership chairman; A. E. LeDoux (A '39) publicity chairman; and A. L. Albright, entertainment and attendance chairman.

Two meetings have been held by the new Subsection which have aroused considerable interest in the area. The Lake Charles area is growing fast industrially and it is expected that it will become very strong in itself and may even become a Section. The Subsection is now making plans for future activities and is soliciting additional members and local members.

North Carolina Section Forms Charlotte Subsection

A Subsection of the North Carolina Section, AIEE was formed at Charlotte, October 5, 1945, following authorization by the executive committee of the section at a meeting in Raleigh, August 16. G. O. Bason (A '37) was elected chairman and E. R. Davis (A '41), secretary-treasurer. The subsection was formed in order to afford electrical engineers in the Charlotte area a chance to get together for discussion of advances in the engineering field and of mutual problems.

It is reported that this new activity of the North Carolina Section has made an excellent start. It offers additional opportunities for members to carry out the aims and purposes of the Institute. Institute members living in the Charlotte area are automatically members of the Charlotte Subsection. Plans for the program of meetings of the Subsection are being prepared.

PERSONAL

Edward L. Moreland (A '11, M '15, F '21) partner, Jackson and Moreland, engineers, Boston, Mass., has been appointed 1945–46 chairman of the AIEE ordnance advisory committee. Mr. Moreland was born in Lexington, Va., July 1, 1885, and was graduated from Johns Hopkins University (mathematics and physics) with a bachelor-of-arts degree in 1905. In 1908 he received a master's degree from the electrical-engineering department, Massachusetts Institute of Technology. In that same year, he entered the employ of D. C. and William B. Jackson, consulting engineers, Chicago, Ill., and Boston, serving as personal assistant to D. C. Jackson (HM '44), senior member of the firm. In 1912 Mr. Moreland was made manager of the Boston office and four years later became a partner in the company. During World War I he was captain and later major of engineers, American Expeditionary Forces, serving with the technical board, and as technical executive of the War Damage Board. In 1919 he formed a partnership with D. C. Jackson for the practice of engineering under the firm name of Jackson and Moreland. In 1935 Mr. Moreland was made head of the department of electrical engineering, Massachusetts Institute of Technology, Cambridge, and in 1938 he was appointed dean. Mr. Moreland is the author of several technical papers and has been active in Institute affairs. He has served on many committees including the following: electric machinery, 1929–31; power generation, 1929–31; transportation, 1931–37 (chairman, 1931–34); technical program, 1931–34; Standards, 1932–42 (chairman, 1934–36); Institute policy, 1933–34; education, 1936–42; transfers, 1938–41; Lamme Medal, 1940–41; and research, 1940–43.

Lee Francis Adams (A '09, M '26, F '42) assistant to the vice-president and manager, standards division, General Electric Company, Schenectady, N. Y., has been appointed 1945–46 chairman of the AIEE committee on safety. He was born in Bellefonte, Pa., and was graduated from Pennsylvania State College with a bachelor-of-science degree in electrical engineering, subsequently receiving an electrical-engineering degree from the same university in 1909. From 1906 until 1907 he was in the testing department, General Electric Company, Schenectady. For the next two years Mr. Adams was an instructor in electrical engineering at Pennsylvania State College, State College. Since 1909 he has occupied various engineering positions, such as designing engineer, application engineer, and commercial engineer in the General Electric Company. Mr. Adams is an executive representative of the General Electric Company in the National Electrical Manufacturers Association, and represents the National Electrical Manufacturers Association on the standards council of the American Standards Association, and on many engineering committees. He is vice-president of the United States National Committee of the International Electrotechnical Commission, and represented the United States at the International Conferences of the commission in 1926 in New York, in 1935 in Scheveningen, Holland, and Brussels, Belgium, and in 1938 in London and Torquay, England. In 1930 Mr. Adams was awarded the James H. McGraw award for his contribution to the manufacturing branch of the electrical industry. Mr. Adams is also a member of the American Society of Testing Materials, Society of Automotive Engineers, and the National Safety Council. He has written a number of papers on application engineering, Standards, and codes.

Leonard Tibbetts Blaisdell (A '20, M '22, F '39), commercial vice-president, General Electric Company, Cleveland, Ohio, has been appointed 1945–46 chairman of the AIEE committee on transfers. Born in Carlisle, Mass., he was graduated in 1904 in marine engineering from the Commonwealth of Massachusetts Nautical Training School. In 1942 he was awarded the honorary professional degree of electrical engineer from the Case School of Applied Science. He has been continuously employed by the General Electric Company since 1904 when he entered the students' testing course for engineering graduates at Lynn, Mass. From 1907 to 1911 he was in application engineering, and supervisor of power-plant installations on land, also on ships of the Merchant Marine and of the United States Navy. For the next six years he was engaged in commercial engineering, Baltimore, Md. In connection with the General Electric Company's activities during World War I Mr. Blaisdell was transferred to the Washington, D. C., office where he remained as manager until 1923. In the latter-mentioned year he was transferred to Dallas, Tex., as district manager in charge of engineering apparatus lines for the several southwestern states. He was elected a commercial vice-president in 1936. In 1939 he was transferred to Cleveland as commercial vice-president in charge of the company's activities on the engineering apparatus lines for the several states of the east central district. Since March of this year he has been on the president's staff of the General Electric Company. Mr. Blaisdell was vice-president, AIEE, 1936 and 1937, representing the South West District (number 7), and has served as chairman, Washington Section, 1923; chairman, Dallas Section, 1929. He is a member of the Cleveland Engineering Society and of the Illuminating Engineering Society.

Truman S. Gray (A'26, M'38, F'45) associate professor of engineering electronics, electrical-engineering department, Massachusetts Institute of Technology, Cambridge, has been appointed 1945–46 chairman of the AIEE committee on instruments and measurements of which he has been a member since 1933. He was born in Spencer, Ind., May 3, 1906, and received the degrees of bachelor of science in electrical engineering (1926) and bachelor of arts (1927) from the University of Texas, and the degrees of master of science (1929) and doctor of science in electrical engineering (1930) from Massachusetts Institute of Technology. He was named assistant in physics at the University of Texas, Austin, in 1924 and remained in that capacity until 1927 when he became research assistant in electrical engineering at the Massachusetts Institute of Technology. In 1930 he was made instructor in electrical engineering at the institute. He became assistant professor in 1935 and associate professor in 1942. Mr. Gray for short periods was with the Leeds and Northrup Company, at General Electric Company, Schenectady, N. Y., and Naval Ordnance Laboratory, Washington, D. C. Recently he has been consultant to the Climatic Research Laboratory, Quartermaster Corps, Army Service Forces, Lawrence, Mass. His AIEE activities include membership on the committee on instruments and measurements 1933–45 (secretary 1939–41, vice chairman 1941–44); and on the joint subcommittee on electronics (now the committee on electronics), 1934–45. In addition he has served on the executive committee of the Boston Section since 1942, and is vice-chairman of the Section for 1945–46. He is the author of several technical papers and a member of the Society for the Promotion of Engineering Education.

E. L. Moreland

L. F. Adams

L. T. Blaisdell

T. S. Gray

James J. Pilliod (M '17, F '34) assistant chief engineer, American Telephone and Telegraph Company, New York, N. Y., has been appointed 1945–46 chairman of the AIEE committee on communication. Mr. Pilliod was born in Chillicothe, Mo., and received the degree of electrical engineer in 1908, and the honorary degree of doctor of engineering in 1939 from Ohio Northern University. In 1908 he became associated with the American Telephone and Telegraph Company and filled various positions in Maumee, Ohio, Chicago, Ill., Indianapolis, Ind., and New York until in 1914 he was named division plant engineer, long-lines department, Chicago. Three years later he was in New York as engineer of transmission, long-lines department, and was in charge of a group handling transmission-engineering work involved in the construction and operation of long-distance telephone lines. In 1920 he was appointed engineer in charge of the long-lines engineering department in New York. Mr. Pilliod was made general manager of the long-lines department in 1941 and two years later was appointed assistant chief engineer of the company. From October 1942 to April 1943 he was loaned to the War Department. Mr. Pilliod has contributed many papers to the technical press on long-distance telephony and telegraphy. He has been active in AIEE affairs and has served on the following committees: membership, 1924–25; communication, 1933–37; board of examiners postwar planning (special committee), 1943–45; electrical standards, February 1945–August 1946; alternate, standards council, American Standards Association, February–December 1945, and award of Institute prizes, 1945–46; board of examiners 1945–46, and the 1946 winter convention.

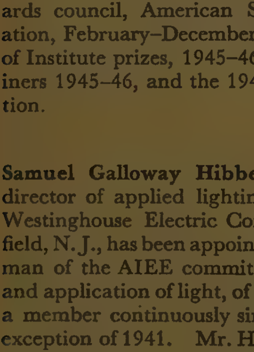
Samuel Galloway Hibben (A '34, M '45) director of applied lighting, lamp division, Westinghouse Electric Corporation, Bloomfield, N. J., has been appointed 1945–46 chairman of the AIEE committee on Production and application of light, of which he has been a member continuously since 1938 with the exception of 1941. Mr. Hibben was born in Hillsboro, Ohio, in 1888, and was graduated from the Case School of Applied Science in 1910. He then joined the MacBeth Glass Company, Pittsburgh, Pa., as illuminating engineer. In 1915 he established an office in Pittsburgh where he worked as consulting engineer. Mr. Hibben's career with the Westinghouse organization began in 1916 but it was cut short a year later when he offered his services to the United States Army. Late in 1917 Mr. Hibben went first to England and then to France with an army searchlight battalion. He rejoined the Westinghouse Company in 1919 and was appointed branch manager at the Cleveland office of the lamp division. A year later he was called to Bloomfield to develop a lighting service bureau which was to become the present commercial engineering department. He was named to his present position in 1933. He is a past national secretary and present director of the Illuminating Engineering Society. He is active in the Society of American Military Engineers, the Electrical Association of New York, and the London Illuminating Engineering Society.

Eivind Urdahl Lassen (A '25, M '33) assistant chief engineer, Cutler-Hammer, Inc., Milwaukee, Wis., has been appointed 1945–46 chairman of the recently formed AIEE committee on industrial control devices. Mr. Lassen was born in Glemmen, Norway, September 30, 1900, and was graduated from the Federal Polytechnical Institute, Zurich, Switzerland, in 1923 with the degree of electrical engineer. His first position upon arrival in the United States in 1924 was as draftsman for Cutler-Hammer, Inc. Later in that same year he was transferred to the engineering department and in 1930 was named to the position of supervising engineer in responsible charge of engineering activities of certain groups and divisions of the company's technical staff. In September of this year Mr. Lassen was appointed assistant chief engineer. Mr. Lassen was secretary-treasurer of the AIEE Milwaukee Section for 1931–32. In addition to his AIEE activities, Mr. Lassen is serving on various technical committees sponsored by the National Electrical Manufacturers' Association, and was active during World War II in committee work sponsored by the Navy Department in the program to bring Navy general specifications for electric control equipment up to date. He is a member of the Engineer's Society of Milwaukee.

S. S. Bloom (M '43) formerly senior engineer, gas and electric division, California Railroad Commission, San Francisco, has become consulting engineer on public-utility questions for Charles C. Bowen and Company, management consultants, San Francisco. Mr. Bloom is a graduate of the University of Idaho.

John Castlereagh Parker (A '04, M '09, F '12) vice-president, Consolidated Edison Company of New York (N. Y.), Inc., and past president of the AIEE has been appointed 1945–46 chairman of the AIEE committee on the Lamme Medal. Doctor Parker was born in Detroit, Mich., April 15, 1879, and received the degrees of bachelor of science in mechanical engineering, master of arts, and electrical engineer in 1901, 1902, and 1904, respectively, from the University of Michigan. In 1935 he was awarded the honorary degree of doctor of engineering by the Stevens Institute of Technology. Doctor Parker entered the testing department of the General Electric Company, Schenectady, N. Y., in 1902 and later became an instructor in mechanical and electrical engineering at Union College, Schenectady. In 1904, and for a decade thereafter, he served the Ontario Power Company at Niagara Falls and as assistant to the chief engineer of the construction company building the lines of the Niagara, Lockport and Ontario Power Company. Later he was transferred from Buffalo to Rochester, N. Y., and placed in charge of the engineering department of the Rochester Railway and Light Company. Doctor Parker re-entered the educational field when, in 1915, he was appointed head of the department of electrical engineering, University of Michigan, Ann Arbor, and continued there for seven years. In 1922 he became associated with the Brooklyn (N. Y.) Edison Company as electrical engineer. In turn he was vice-president in charge of engineering and president of the company, and in 1936 when the company became a part of the Consolidated Edison of New York Doctor Parker was appointed vice-president of the latter organization. Doctor Parker, president of AIEE 1938–39, has been active in AIEE affairs. His committees include: Student Branches, 1919–20; educational, 1919–22 (chairman, 1919–20); Sections, 1920–22; Standards, 1923–32; electric machinery, 1924–27; power generation, 1924–26; power transmission and distribution, 1924–26; Lamme Medal, 1931–34 and 1944–47; Edison Medal, 1938–41; executive, 1938–39 (chairman, 1938–39) and 1940–41; and the Hoover Medal board of award, 1941–49.

L. J. N. Mothersill (A '35) lieutenant, Royal Canadian Navy Volunteer Reserve, has rejoined the Brown Instrument Company, Toronto, Ontario, Canada. Lieutenant Mothersill has had five years' service with the Admiralty and the Canadian Navy.



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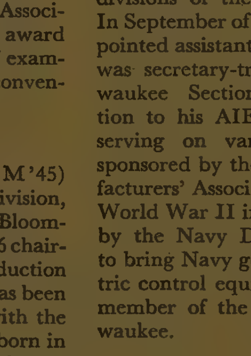

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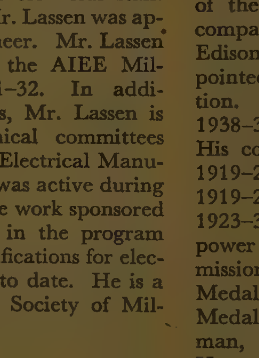

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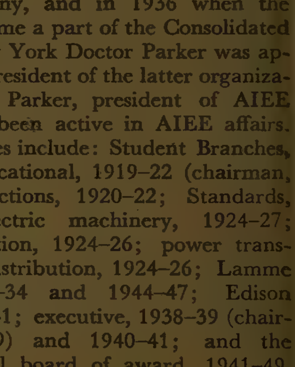

J. C. Parker

R. A. Millikan (M '22, HM '33) formerly chairman, executive council, California Institute of Technology, Pasadena, has retired. Doctor Millikan was born at Morrison, Ill., in 1868, and received the degree of bachelor of arts from Oberlin College in 1891, and, in 1895 the degree of doctor of philosophy from Columbia University. He tutored in physics at Oberlin (Ohio) College, and in 1896 became an assistant in physics at the University of Chicago (Ill.). In 1921 Doctor Millikan became director, Norman Bridge Laboratory of Physics, and chairman of the executive council, California Institute of Technology. He was the Edison Medalist of 1922, and in 1923 was awarded the Nobel prize for physics by the Royal Swedish Academy. He has contributed liberally to technical literature in his numerous books including "A Course of College Experiments in Physics," 1906; "Electricity, Sound and Light," 1908 and "Practical Physics," 1920. Many articles written by Doctor Millikan have been published in various technical journals. He served on the AIEE Edison Medal committee, 1923–28, 1934–40, and on the electrophysics committee, 1923–30. He was awarded the 1937 Franklin Medal of the Franklin Institute, "for his isolation and measurement of the fundamental unit of electricity, the electron."

H. P. Richmond (A '36) formerly general superintendent, Jersey Central Power and Light Company, Asbury Park, N. J., recently resigned. In 1931 Mr. Richmond was a cadet engineer, Eastern New Jersey Power Company where he gained practical experience in the powerhouse, line department, meter, and test departments. Later he became assistant to the gas engineer of the Jersey Central Power and Light Company, which absorbed the Eastern New Jersey Power Company, and in 1936 he was named district manager of the company at Dover. **C. A. Mullen** (A '20, M '20) superintendent, northern division, has been appointed general superintendent of operations, Asbury Park. Since 1909 Mr. Mullen has been identified with a number of companies including the Northern Indiana Gas and Electric Company, Hammond; Brown Manufacturing Company, Zanesville, Ohio; American Rolling Mill Company, Zanesville; and the Penn Central Light and Power Company, Altoona, Pa. In 1914 he was in charge of the testing department of the Ohio Service Company, Coshocton, nine years later was appointed superintendent of substations. Subsequently he transferred to the Pennsylvania Power and Light Company whence he moved in 1927 to Asbury Park where for four years he was superintendent of operations of the former Eastern New Jersey Power Company. Upon purchase of that company by Jersey Central Power and Light Company in 1931 Mr. Mullen was named superintendent of the Morristown division, a position he held until his recent promotion.

H. R. Summerhayes (A '07, F '39) consulting engineer, central-station engineering division, General Electric Company, Schenectady, N. Y., since 1939, retired recently after 49 years of service with that company. Mr. Summerhayes was born in 1875 at Camp Apache, Ariz., and was graduated from Stevens Institute of Technology in 1896 as mechanical engineer. In that same year he joined the expert course in the testing department, General Electric Company. In the foreign engineering department of the company from 1897 to 1911 he had charge of all engineering recommendations on central-station and power and mining projects in foreign countries. He was transferred in 1911 to work in the lighting department, subsequently becoming assistant engineer in that department. Nine years later the lighting department became the central-station department, and Mr. Summerhayes was made engineer. From 1920 to 1939 he had general direction of all the application engineering in the central-station field. He was sent to Europe in 1924 to attend the World Power Conference in London, and to observe central-station practices in various countries. Again in 1935 he went to Europe as a United States representative to attend the meetings of the International Electrotechnical Commission in Holland and Belgium, and the meetings of the International Conference on Large High-Tension Systems in Paris. He was coauthor of a paper entitled "Voltage Standardization of A-C Systems," which aided in establishing a standard for the industry. Mr. Summerhayes has served on the protective devices and Standards committees of the AIEE, and on committees of the National Electric Light Association and the National Electrical Manufacturers Association.

J. L. Gray (M '38) formerly construction engineer, engineering department, East Tennessee Light and Power Company, Bristol, has been appointed manager of power for the city of Bristol in a reorganization resulting from the dissolution of the system operation of the company and transfer of the various units to local municipal government, co-operatives, and the Tennessee Valley Authority. Mr. Gray was graduated with a bachelor-of-science degree in electrical and mechanical engineering from Clemson College in 1919. Directly, he went with Henry L. Doherty and Company on the Toledo (Ohio) Railway and Light Company as junior engineer. Subsequently, he served Durham (N. C.) Public Service Company; Ohio Public Service Company both in Cleveland and in Alliance, and Citizens Light and Power Company, Adrian, Mich. Mr. Gray is a member of the Engineering Society of Detroit.

Abe Tilles (A '30, M '36) electrical engineer, War Research Project, University of California, Berkeley, has joined the staff of the Pacific Gas and Electric Company, San Francisco, Calif. He was graduated from the University of California in 1928 and in that year entered the testing laboratories of the City of Los Angeles (Calif.) Bureau of Power and Light. In 1930 Mr. Tilles became a teaching associate for the University of California and subsequently was made an instructor. He did electrical planning and design for the Los Angeles Bureau of Power and Light in 1936 and in the same year was appointed student counselor for the University of California Branch of the AIEE.

A. C. Monteith (A '25, M '40) manager, industry engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa., since 1941 has been appointed assistant manager, headquarters engineering, and director of education. In the former capacity he will direct headquarters-engineering activities in the absence of AIEE Past President C. A. Powel (M '20, F '41) assigned to the military government of Germany. Mr. Monteith was born in Brucefield, Ontario, Canada, and received the degree of bachelor of science from Queens University in 1923. He joined the Westinghouse Company in 1924. He was 1944–45 chairman of the AIEE Standards committee of which he had been a member since 1941. He received honorable mention for the best paper in engineering practice in the 1937 AIEE prize awards, and has served on the power generation committee, 1938–44; protective devices, 1940–42; and Standards, 1941–44.

J. K. Thompson (A '37, M '44) formerly manufacturing engineer, headquarters manufacturing-engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chief engineer in charge of the transformer and fluorescent instant-start departments, United Appliance Company, Rochester and Geneseo, N. Y. Mr. Thompson was born in Garrettsville, Ohio, and was graduated from Case School of Applied Science with the degree of bachelor of science in electrical engineering in 1931. Before his graduation he was employed for short periods by the Western Electric Company, New York, N. Y., Cleveland (Ohio) Transformer Company, and the National Carbon Company. Following his graduation he served for one year as laboratory assistant with the Brush Laboratories Company, Cleveland, and for ten years as chief engineer, France Manufacturing Company, Cleveland.

W. A. Kelley (A '38) lieutenant colonel, Signal Corps, Army of the United States, has been appointed commanding officer, Lexington (Ky.) Signal Depot. Colonel Kelley entered military service in 1942 and was assigned to the Office of the Chief Signal Officer. Previously he had been with E. D. Smith and Sons, Pittsfield, Mass., and the War Production Board, Washington, D. C. He is the author of "The Universal Catalog System" which is used by the United States Army Air Forces, the British Army Staff, the British War Office, and the Navy Catalog Office.

H. C. Madsen (A '42) manager, university relations, educational department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed manager, industrial relations, Bryant Electric Company, Bridgeport, Conn., a subsidiary of the former company. Mr. Madsen was born in 1913 in Pittsburgh, and was graduated from Pennsylvania State College in 1935 with a bachelor-of-science degree in electrical engineering. Following employment by the Philco Radio and Television Corporation, Philadelphia, Pa., he became associated with the Westinghouse Company.

William H. Reed (A '26, M '43) electrical engineer and consultant, Bruce Electric Company, New York, N. Y., has been appointed the 1945–46 chairman of the AIEE committee on marine transportation of which he has been vice-chairman since 1943 and a member since 1926. Mr. Reed was born in Norwalk, Conn., March 13, 1880, and was educated in public and private preparatory schools there. From 1898 to 1918 he was engaged in design, construction, and operation of central power plants and industrial power and lighting installation, throughout the eastern United States. In 1918 he was named electrical engineer, Tietjen and Lang Dry Dock Company, Hoboken, N. J. (later known as the Todd Shipyards Corporation), in charge of design and supervision of electric power, lighting, and communication installations on ships under repair and conversion in that plant. He was also in charge of the company's generating plant and substations, and of design and supervision involving change of motive power from steam engines to electric motors. He severed his connection with that corporation in March 1945. Mr. Reed is a member of the Society of Naval Architects and Marine Engineers.

H. C. Wolf (A '16, M '23) president of the Atlanta (Ga.) Gas Light Company, has been elected managing director of the American Gas Association, New York, N. Y. Mr. Wolf was born in Edwardsville, Ill., and was graduated from the University of Illinois with the degrees of bachelor of science, master of science, and electrical engineer. Upon graduation in 1914 he was employed by the State Public Utilities Commission of Illinois, Springfield, as service inspector, later becoming assistant engineer. In 1916 he became affiliated with the Edwardsville (Ill.) Water Company as superintendent. From 1917 until 1919 he served as an officer, United States Army Corps of Engineers. From then until 1921 Mr. Wolf was industrial engineer with Arthur Young and Company, and Griffenhagen and Associates, Ltd., in reorganizing and standardizing engineering and related organizations and units in the United States and Canada. In 1921 he served as assistant chief engineer, Public Service Commission of Maryland, Baltimore, and in 1922 became chief engineer of the commission. In 1929 Mr. Wolf resigned to become assistant to the vice-president of the Central Public Utility Corporation. Four years later he became vice-president of the Consolidated Electric and Gas Company, New York, N. Y., and in 1934 assumed the duties of the president of the Central Indiana Gas Company, Muncie, Ind., and associated companies in Indiana. In 1938 he was elected president of the Atlanta Gas Light Company.

John Durwald Miner, Jr. (M '42) manager, aviation engineering, Westinghouse Electric Corporation, Lima, Ohio, has been appointed 1945–46 chairman of the AIEE committee on air transportation. Mr. Miner was born in East Greenwich, R. I., October 3, 1903, and was graduated from Brown University in 1925 with the degree of bachelor of science in electrical engineering. In 1925 he enrolled in the graduate-student course at the Westinghouse Electric Corporation and attended the engineering school and electrical design school. Subsequently, he was appointed design engineer on various types of rotating machinery in the motor division. In 1928 he was transferred to the small-motor division and worked chiefly on the design of rotating equipment for use with radio, particularly aircraft radio. Mr. Miner transferred to Lima when the small-motor division was relocated there in 1937. Two years later he was made section engineer on universal motors, in 1940, section engineer on universal and d-c motors, and section engineer on aircraft equipment in 1941. In 1942 he was named manager of engineering, small-motor division. Two years later in 1944, he was appointed to his present position with the Westinghouse company. Mr. Miner has served on several AIEE committees, including air transportation, technical program, Standards, and award of Institute prizes.

F. L. Rohrbach (A '13, M '28) formerly underground engineer, Washington Water Power Company, Spokane, has retired after completing 38 years of continuous service with that company. Mr. Rohrbach was born in Sunbury, Pa., and was graduated from Pennsylvania State College with a degree in electrical engineering in 1903. After a period of four years in the test department of the General Electric Company he became associated, in 1907, with the Washington Water Power Company as a clerk. He later served as engineer, underground system, and maintenance engineer of substations continuing in charge of underground systems.

W. H. Reed

J. D. Miner, Jr.

Zay Jeffries

Zay Jeffries (M '36, F '42) vice-president, General Electric Company, in charge of chemical department at Pittsfield, Mass., has been chosen to receive the John Fritz Medal for 1946. Mr. Jeffries was born April 22, 1888, at Willow Lake, S. Dak., and received the degrees of bachelor of science and metallurgical engineer from the South Dakota School of Mines, and the degree of doctor of science from Harvard University. From 1911 until 1917 Doctor Jeffries was a member of the faculty of the Case School of Applied Science, Cleveland, Ohio, and later was made a member of the corporation. He has been a consultant for the incandescent-lamp department of the General Electric Company since 1914 and was made technical director in 1936. Doctor Jeffries is a metallurgist of note particularly with regard to nonferrous metals and is a consultant in electrochemical and electrometallurgical work. He has made many contributions on the metallography of tungsten, on the constitution of steel, on the theory of hardening of metals, and on other fundamental subjects. He has published more than 50 works on metallic and nonmetallic engineering materials. He has received the James Douglas Medal from the American Institute of Mining and Metallurgical Engineers, the Sauveur award from the American Society of Metals, the Clamer Medal of the Franklin Institute, and the powder metallurgy medal of Stevens Institute of Technology. Doctor Jeffries, in addition to being an officer in several corporations and past-president of the American Institute of Mining and Metallurgical Engineers, is active in numerous professional societies in engineering and science in the United States as well as in other countries. An account of the award appears elsewhere in this issue.

F. H. Craton (A '31, M '38) formerly manager, industrial haulage division, General Electric Company, Erie, Pa., has been named assistant manager, transportation divisions, Erie Works of the company. Mr. Craton was born in Syracuse, N. Y., and was graduated from Syracuse University as mechanical engineer. He became affiliated with the General Electric Company in 1924.

H. J. Billica (A '36, M '36) formerly district representative, sales department, the Copperweld Steel Company, Glassport, Pa., has been appointed Pacific district manager with headquarters in San Francisco, Calif. Mr. Billica joined the company in 1943 after serving as senior priority adviser in the power division, Office of War Utilities of the War Production Board, Washington, D. C. Prior to that he had been with the Indiana Steel and Wire Company, Muncie.

J. S. Murray (A '21, M '31) formerly chief electrical engineer, Follansbee (W. Va.) Steel Corporation, has been appointed Pittsburgh, Pa., district manager, Alliance (Ohio) Machine Company. A native of Amsterdam, N. Y., he has been associated with the Follansbee Company since 1921. In 1943 he was elected national treasurer of the Association of Iron and Steel Engineers.

L. N. McClellan (A '14, F '38) chief electrical engineer, United States Bureau of Reclamation, Denver, Colo., has been appointed assistant chief engineer, electrical and mechanical division of the bureau. Mr. McClellan was graduated from the University of Southern California in 1911 with a bachelor-of-science degree in electrical engineering. First employed by the Bureau of Reclamation in August 1911 he served in various capacities. He spent a year in the United States Army Corps of Engineers during World War I, and in 1924 was employed in the operating department of the Southern California Edison Company. Since 1924 he has been chief electrical engineer, Bureau of Reclamation, in charge of design, construction, and operation of all power plants, pumping plants, transmission lines and substations built and operated as federal irrigation projects. Mr. McClellan is the author of papers on the Boulder Dam project published by the Institute, and was a member of the AIEE committee on power transmission and distribution, 1933–36, and a vice-president 1937–39.

L. S. Wing (A '27, M '34) a member of the Federal Power Commission, Washington, D. C., has been appointed regional engineer at San Francisco, Calif. Mr. Wing was graduated from the South Dakota State College of Agriculture and Mechanical Arts and in 1916 took the student course with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Subsequent positions were with the Consumers Power Company, Jackson, Mich.; the Great Western Electro-Chemical Company, San Francisco, and the American Smelters and Refining Company, Tacoma, Wash. He has been with the Federal Power Commission since 1934.

James DeKiep (M '43) formerly manager, a-c motor engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chief engineer in charge of electrical and mechanical design and development. Mr. DeKiep was graduated from the University of Michigan in 1927 with a bachelor-of-science degree in electrical engineering. He became associated with the Westinghouse company in 1929.

OBITUARY • • • • •

Peder Reinhardt Pedersen (A '23) formerly designer, electrical department, Phelps Dodge Corporation, New York, N. Y., died recently. Mr. Pedersen was born in Skaade, Denmark, October 4, 1893, and was graduated from the Institute of Electrical Engineering at Aarhus, Denmark, in 1918. From 1918 to 1920 he was engaged in designing electric machinery in Copenhagen, Denmark. Later he served the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., Stone and Webster, Boston, Mass., and, on many occasions in his career, was associated with Sanderson and Porter, engineers, New York, N. Y. From 1933 to 1937 he was with the Braden Copper Company and the Kennicott Company, both in Rancagua, Chile, South America. In 1939 Mr. Pedersen was a designer for Archer E. Wheeler, New York, N. Y.

Malcolm MacLaren (A '05, M '25) professor emeritus, Princeton (N. J.) University, died September 24, 1945. Professor MacLaren was born in Annapolis, Md., in 1869, and was graduated from Princeton University in 1890 as a bachelor of arts, in 1892 as an electrical engineer, and in 1893 as a master of arts. From 1893 until 1908 he was associated with the Westinghouse Electric and Manufacturing Company both in the United States and in England. In the latter year he became chairman of the department of electrical engineering at Princeton University and held that post until his retirement in 1937. During World War I he served as a major with the United States Army Corps of Engineers, and was assigned to the power section of the War Industry Board. Professor MacLaren was the author of "The Rise of the Electrical Industry During the Nineteenth Century." He served on the following AIEE committees: superpower system, 1920–21; education, 1924–25; Lamme Medal, 1933–36.

Beshara Elian Battit (A '35) captain, Air Corps, United States Army, was killed in line of duty with the United States Strategic Air Forces in France, October 11, 1944. Captain Battit was born in Boston, Mass., and was graduated from the Massachusetts Institute of Technology with a degree in electrical engineering in 1934. Following graduation he became affiliated with the Massachusetts Institute of Technology as an assistant instructor. Later he joined the A. C. Neilson Company, Chicago, Ill., and then Jackson and Moreland, engineers of Boston. He entered the military service on February 7, 1942, and before going overseas was stationed at Camp Murphy, Fla., Boston; Fort Monmouth, N. J.; and Wright Field, Ohio.

Robert Otjen Buehner (M '36, F '43) electrical engineer, Weatherhead Company, Cleveland, Ohio, died July 23, 1945. He was born in Milwaukee, Wis., January 9, 1903. Employed by Allis-Chalmers Manufacturing Company, Milwaukee, from 1923 to 1927, Mr. Buehner, in the latter year, accepted a position with the American Steel and Wire Company, Waukegan, Ill., as Chicago district electrical engineer. He was made assistant district engineer in 1929 and company electrical engineer in 1943. In 1942 he was transferred to Joliet, Ill., and in 1943 to Cleveland. Mr. Buehner remained with the American Steel and Wire Company until January 1945 when he entered the employ of the Weatherhead Company.

Myron Creese (A '07, M '40) professor of electrical engineering, University of Maryland, College Park, died recently. He was born in Red Rock, Pa., July 26, 1883, and was graduated from the Pennsylvania State College, State College, Pa., with the degrees of bachelor of science in electrical engineering in 1905 and electrical engineer in 1906. In 1907 he was appointed instructor in electrical engineering and physics at the Maryland State College, then named the Maryland Agricultural College. In turn he became assistant professor, associate professor, and professor. Early in his career he spent summers working for the General Electric Company at Chester, Pa., and for the Westinghouse Electric and Manufacturing Company, at East Pittsburgh, Pa.

MEMBERSHIP • • •

Recommended for Transfer

The board of examiners, at its meeting of October 18, 1945, recommended the following members for transfer to the grade of membership indicated. Any objections to these transfers should be filed at once with the secretary of the Institute.

To Grade of Fellow

Burrows, C. R., chairman, Committee on Propagation, N.D.R.C., member of tech. staff, Bell Telephone Labs., Inc., New York, N. Y.
Cowan, F. A., trans. engr., American Tel. & Tel. Co., New York, N. Y.
Dee, T. C., gen. supt., Ohio Edison Co., Akron, Ohio.
Fox, J. C., elec. engr., Virginian Railway Co., Princeton, W. Va.
Marbury, R. E., mgr., capacitor sec., Westinghouse Electric Corp., E. Pittsburgh, Pa.
Stansel, N. R., spec., ind. engg. div., General Electric Co., Schenectady, N. Y.
Tyvand, J. A., chief engr., Wisconsin Gas & Electric Co., Racine, Wis.

7 to grade of Fellow

To Grade of Member

Anderson, L. W., engr., General Electric Co., Louisville, Ky.
Barrell, R. W., Jr., locomotive engg. div., General Electric Co., Erie, Pa.
Bates, H. H., dist. plant supt., American Tel. & Tel. Co., Cincinnati, Ohio.
Biele, C. E., Comdr., USNR, div. of electronics, CNO, Navy Dept., Washington, D. C.
Bruce, W. C., equip. maint. engr., Southern California Tel. Co., Los Angeles, Calif.
Bumpas, W. E., gen. elec. foreman, U. S. Bureau of Reclamation, Kremmling, Colo.
Coone, L. A., aircraft apparatus, General Electric Co., Atlanta, Ga.
De Villiers, I., head office engr., Electricity Supply Comm., Johannesburg, S. Africa.
DiToro, M. J., senior elec. engr., Hazeltine Electronics Corp., Little Neck, N. Y.
Emmerling, E. J., Captain, Signal Corps, U. S. Army, Watson Laboratories, Red Bank, N. J.
Fleming, J. G., research engr., Bristol Company, Waterbury, Conn.
Fosholt, S. K., assoc. engr., Stanley Engineering Co., Muscatine, Iowa.
Fulton, R. A., Jr., engr., Western Electric Co., Kearny, N. J.
Haley, J. L., supt., elec. meter dept., Memphis Light, Gas & Water Div., Memphis, Tenn.
Hansen, A., Jr., instrument engr., General Electric Co., Lynn, Mass.
Hill, D. A., commercial engr., Ohio Public Service Co., Cleveland, Ohio.
Jagger, C. A., elec. engg., General Electric Co., Schenectady, N. Y.
Leightman, H., cons. engr., Sterick Bldg., Memphis, Tenn.
Mascaro, W. O., elec. engr., Atlantic Refining Co., Philadelphia, Pa.
Miller, J. B., assoc. prof. of elec. engg., Bucknell University, Lewisburg, Pa.
Moran, J. M., research assoc., Harvard University, Cambridge, Mass.
Morgan, W. D., test engr., Memphis Light, Gas & Water Div., Memphis, Tenn.
Olive, J. M., chief street lighting engr., Memphis Light, Gas & Water Div., Memphis, Tenn.
Ratajczak, F. X., elec. engr., Gilbert Associates, Inc., Reading, Pa.
Sachs, S. C., owner, S. C. Sachs Co., St. Louis, Mo.
Sievers, G. F., Sr., elec. engr., Navy Department, Washington, D. C.
Smith, D. S., junior research engr., National Research Council, Ottawa, Can.
Suski, H. M., project engr., Naval Research Laboratory, Anacostia Sta., Washington, D. C.
Sussman, H. W., elec. engr., Columbia Electric Mfg. Co., Cleveland, Ohio.
Wall, H. R., Lieut., USNR, Search Radar Section, Navy Yard, South Boston, Mass.
Ward, J. E., Jr., elec. engr., Naval Ordnance Lab., Navy Yard, Washington, D. C.
Zacherle, B. H., elec. engr., United Engineers & Constructors, Inc., Philadelphia, Pa.

32 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Any member objecting to the election of any of these candidates should so inform the secretary before December 15, 1945, or February 15, 1946, if the applicant resides outside of the United States or Canada.

To Grade of Member

Abbott, A. C. (Re-election), The Shawinigan Water & Power Co., Montreal, P. Q., Canada
Brennan, M. J., E. J. Electrical Corp., New York, N. Y.
deNagy, L. G., USED, Oak Ridge, Tenn.
de Neuf, D. K., Raytheon Mfg. Co., New York, N. Y.
Edick, R. S. (Re-election), George S. Armstrong & Co., Inc., New York, N. Y.
Eisner, J. H., Auburn Spark Plug Co., Inc., Auburn, N. Y.
Farquhar, W. A., Lt. USNR, Office of Chief of Naval Operations, Washington, D. C.
Fredlund, E. F. G., AB Elektrolux's Laboratory, Stockholm, Sweden
Gibbs, J. T., Volunteer Electric Cooperative, Decatur, Tenn.
Gove, R. D., Cutler Hammer, Inc., Milwaukee, Wis.
Gring, M. H. (Re-election), Penna. Power & Light Co., Shenandoah, Pa.
Grogan, R. M., Long Island Lighting Co., Roslyn, L. I., N. Y.
Hirsh, D. (Re-election), Hirsh Electric Co., Houston, Tex.
Horvath, J., Jr., General Electric Co., Pittsfield, Mass.
Klauder, L. T. (Re-election), Louis T. Klauder & Associates, Philadelphia, Pa.
Lamb, M. D. (Re-election), Commonwealth Edison Co., Chicago, Ill.
Lamont, L. M., Westinghouse Electric Corp., Boston, Mass.
Lang, K. A., Lindberg Engineering Co., Chicago, Ill.
Leadbetter, J. W., Univ. of Notre Dame, Notre Dame, Ind.
Legate, R. M., Central Technical Power Board, Calcutta, India
Losie, W. E. (Re-election), The Detroit Edison Co., Detroit, Mich.
Marrotte, L. H. (Re-election), Hydro-Quebec, Montreal, P. Q., Canada
McCaughrin, W. O., Supreme Power Supplies, Ltd., Mimico, Ont., Canada
McDougald, A. D. (Re-election), 12th Naval Dist. Headquarters, San Francisco, Calif.
McFarland, G. L., General Electric Co., Schenectady, N. Y.
Montgomery, A. W., Standard Telephones & Cables, Ltd., London, England
Moulton, B. S. (Re-election), The Commonwealth & Southern Corp., Jackson, Mich.
Myers, V. A., National Carbon Co., Inc., Cleveland, Ohio
Neale, R. D., Canterbury University College, Christchurch, N. Z.
Newton, A. H. (Re-election), Signal Corps, U. S. Army, Philadelphia, Pa.
Niemann, W. J. (Re-election), Commonwealth Edison Co., Chicago, Ill.
Rupp, J. L., National Battery Co., Depew, N. Y.
Skurka, M., Maj., A.C., A.P.O., New York, N. Y.
Van Kirk, R. W., General Elec. Co., Beaumont, Tex.
Waghorne, A. C., Southwestern Public Service Co., Denver City, Tex.
Waldorf, H. J., Thomson's Electrical Works, Montreal Que., Can.
Ware, D. H., General Electric Co., Schenectady, N. Y.
Willson, G., Cable Works of Telefonaktiebolaget L M Ericsson, Alvsjo, Sweden

38 to grade of Member

To Grade of Associate

United States and Canada

1. North Eastern

Cotton, F. E., Jr., Naval Training School, M.I.T., Boston, Mass.
Fenmen, S. M., Mass. Inst. of Tech., Cambridge, Mass.
Fischer, W. O., Simplex Wire & Cable Co., Cambridge, Mass.
Hammond, G. H., Tufts College, Medford, Mass.
Johnson, R. A., Simplex Wire & Cable Co., Cambridge, Mass.
Neal, F. M., Corning Glass Wks., Corning, N. Y.
Stanfield, T. O., General Electric Co., Pittsfield, Mass.

2. Middle Eastern

Bracken, J. M., Phila. Navy Yard, Philadelphia, Pa.
Corpening, S. L., Phila. Elec. Co., Norristown, Pa.
Dosey, H. W., U. S. War Dept., Cleveland, Ohio
Fancher, R. L., Jr., Westinghouse Elec. Corp., East Pittsburgh, Pa.
Fryer, L. C., Leeds & Northrup Co., Philadelphia, Pa.
Fulton, L. F., Lt. (sg) U.S.M.S., Turbo-Elec. School, Chester, Pa.
Gealt, A. E., Brown Instrument Co., Philadelphia, Pa.
Jacobs, O. R., Lear, Inc., Piqua, Ohio
Kettlehake, M. W., American Tel. & Tel. Co., Dayton, Ohio
Kramer, J. F., Lt., Sig. C., U.S.A., Cleveland, Ohio
Murphy, R. J., Bureau of Ships, Navy Dept., Washington, D. C.
Nonneman, H. S., Dayton Power & Light Co., Dayton, Ohio
Phillips, J. D., General Electric Co., Erie, Pa.
Sherman, G. W., 111, AAF Air Tech. Serv. Cmd., Dayton, Ohio
Summers, R. M., Leeds & Northrup Co., Philadelphia, Pa.
Towle, P. A., Leeds & Northrup Co., Philadelphia, Pa.
Wilbur, J. C. (Re-election), General Electric Co., Akron, Ohio
Wilhoit, G. D., Westinghouse Electric Corp., Huntington, W. Va.
Williams, D. R., Naval Ordnance Laboratory, Washington, D. C.
Wise, J. (Re-election), Baltimore & Ohio Railroad Co., Toledo, Ohio

3. New York City

Bock, R. O., Arma Corp., Brooklyn, N. Y.
Bolton, W. J., Queens Borough Gas & Elec. Co., Far Rockaway, N. Y.
Challenner, A., Major, U. S. Army, Sig. Corps Engg. Labs., Bradley Beach, N. J.
Cunniffe, T. G., Ensign, U. S. Naval Reserve, New York, N. Y.
Davis, S., Otis Elevator Co., New York, N. Y.
Fasick, R. C., Bell Telephone Labs., New York, N. Y.
Figiel, W. J., Otis Elevator Co., New York, N. Y.
Gambuzza, M. C., Todd Shipyard Corp., Hoboken, N. J.
Goldberg, H. S., Cole Electric Products Co., Long Island City, N. Y.
Kelly, J. M., H. A. Fraser, Inc., New York, N. Y.
Kenny, J. A., Hazeltine Electronics Corp., Bayside, L. I., N. Y.
Magee, W. A., Capt., Sig. Corps Engg. Labs., Bradley Beach, N. J.
Martins, A. S., Bell Telephone Labs., New York, N. Y.
Mascharka, L. A. (Re-election), Westinghouse Electric Intl. Co., New York, N. Y.
Ridpath, L. W., Federal Telephone & Radio Corp., Newark, N. J.
Shepard, W. H., Ens., USNR, c/o F.P.O., New York, N. Y.
Stefanell, R., Federal Telecommunications Labs., New York, N. Y.
Strelinger, J. C., Ebasco Services, Inc., New York, N. Y.
Willis, E. S. (Re-election), Bell Telephone Labs., New York, N. Y.
Wulfken, A. J. (Re-election), Amer. Transformer Co., Brooklyn, N. Y.

4. Southern

Calvert, R. C. M., Jr., Newport News Shipbuilding & Dry Dock Co., Newport News, Va.
Conoley, J. J., Southern Bell Tel. & Tel. Co., Atlanta, Ga.
Field, B. W., T/4, Tennessee Eastman Corp., Oak Ridge, Tenn.
Jenkins, J. E., Armature Winding Co., Charlotte, N. C.
Kirk, R. C., Kyle Corp., Atlanta, Ga.
Nuttall, E. D., Southwestern Gas & Elec. Co., Shreveport, La.
Phillips, C. H., Southern Bell Tel. & Tel. Co., Atlanta, Ga.
Stouse, L. E., Jr., Laurinburg-Maxton AAB, Maxton, N. C.
Weiss, R. L., Lieut., USAAF, Maxwell Field, Montgomery, Ala.
Wortman, W. J. (Re-election), Duke Power Co., Charlotte, N. C.
Zehnder, R. J., Navy Yard, Charleston, S. C.

5. Great Lakes

Atwood, A. R., Wisconsin Electric Power Co., Milwaukee, Wis.
Blank, H. F., Louis Allis Co., Milwaukee, Wis.
Burroughs, H. A., Automatic Electric Co., Chicago, Ill.
Carmody, B. T., Swift & Co., Chicago, Ill.
Daniel, H. K., Chrysler Corp., Highland Park, Mich.
Doehler, G. C., Hevi Duty Electric Co., Milwaukee, Wis.
Evans, N. A., Harnischfeger Corp., Milwaukee, Wis.
Gabriel, N. H., Defoe Shipbuilding Co., Bay City, Mich.
Grabowski, L. R., Defoe Shipbuilding Co., Bay City, Mich.
Hall, J. L., Defoe Shipbuilding Co., Bay City, Mich.
Halleck, M. C., General Electric Co., Fort Wayne, Ind.
Henderson, J. E., Carnegie-Illinois Steel, Chicago, Ill.
Hoffman, N. W. (Re-election), Wisconsin Elec. Power Co., Milwaukee, Wis.
Kowal, C. F., Louis Allis Co., Milwaukee, Wis.
Kremski, E. S., Louis Allis Co., Milwaukee, Wis.
Lemmer, F. R., Louis Allis Co., Milwaukee, Wis.
McDaniels, R. R., Carnegie-Ill. Steel Corp., Chicago, Ill.
Mehta, T. N., Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Rahrig, G. O., Consumers Power Co., Jackson, Mich.
Reed, W. H., Commonwealth Edison Co., Chicago, Ill.
Robinson, F. J., Ill. Bell Tel. Co., Chicago, Ill.
Rosenberg, F. W., Louis Allis Co., Milwaukee, Wis.
Roush, D. N., Westinghouse Elec. Corp., Chicago, Ill.
Shaler, P. M., The Commonwealth & Southern Corp., Jackson, Mich.
Smeaton, R. W., Allis Chalmers Mfg. Co., West Allis, Wis.
Ten Eick, R. A., General Motors, Indianapolis, Ind.
Tower, H. A., Central Ill. Public Serv. Co., Springfield, Ill.
Ullrich, W. J., Louis Allis Co., Milwaukee, Wis.
Umnitz, M. B., Western Elec. Co., Chicago, Ill.
Waldron, V. L., Kuhlman Electric Co., Bay City, Mich.
Weidner, E. G., Louis Allis Co., Milwaukee, Wis.
Wichman, J. A., Louis Allis Co., Milwaukee, Wis.
Wightman, F. R., Public Service Co. of No. Ill., Chicago, Ill.
Wintrode, W. C., General Electric Co., Fort Wayne, Ind.
Wise, E. G., Westinghouse Elec. Corp., Chicago, Ill.
Wood, R. A., Line Material Co., So. Milwaukee, Wis.
Ziegler, O. J., Kuhlman Electric Co., Bay City, Mich.

6. North Central

Hobday, L. T., Mountain States Tel. & Tel. Co., Denver, Colo.

7. South West

Arnold, J. B., Arnold-Stubenbord, Inc., San Antonio, Texas
Basham, R. B., Consolidated-Vultee Aircraft Corp., Ft. Worth, Texas
Blanton, T. C., Wilson Electrical Equipment Co., Houston, Texas
Chimene, I. E., 2102 Kingston Drive, Houston, Texas
Dryer, E. D., Missouri Public Service Corp., Warrensburg, Mo.
Hambrick, W. G., Hambrick Electric Co., Houston, Texas
Herrington, C. R., Southwestern Public Service Co., Amarillo, Texas
Hoffmeister, R. G., Texas Power & Light Co., Dallas, Texas
Hughes, H. L., Public Service Co., Lawton, Okla.
King, L. L., Southwestern Bell Telephone Co., Oklahoma City, Okla.
Luckey, D. E., Texas Electric Service Co., Ft. Worth, Texas
McNary, T. H., Jr., Boeing Airplane Co., Wichita, Kans.
Peevey, J., Supervisor of Shipbuilding, U.S.N., Orange, Texas
Seip, N. W., General Electric Co., St. Louis, Mo.
Shaffer, B. W., Southwestern Bell Telephone Co., Tulsa, Okla.
Smith, C. A., Oklahoma Gas & Electric Co., Oklahoma City, Okla.
White, M. H., Dallas Power & Light Co., Dallas, Texas

8. Pacific

Barrington, J. D., General Electric Co., San Francisco, Calif.
Caruthers, R. W. E., General Electric Co., San Francisco, Calif.
Chapin, W. A. Jr., Lt. U.S.N.R., c/o F.P.O., San Francisco, Calif.
Davis, W. L., Southern Calif. Telephone Co., Los Angeles, Calif.
Gumm, C. C., Jr., Lt., USNR, U. S. Naval Hospital, Mare Island, Calif.
Harris, E. B., U. S. Naval Air Station, Alameda, Calif.
McDaniel, G., Consolidated Engineering Corp., Pasadena, Calif.
Springfield, C. E., Shell Oil Co., Martinez, Calif.
Swanson, N. E., Goodyear Synthetic Rubber Corp., Torrance, Calif.
Van Nice, J. H., Consolidated-Vultee Aircraft Corp., San Diego, Calif.
Wessling, J. R., U. S. Naval Air Station, Alameda, Calif.

9. North West

Bracchi, R. R., General Elec. Co., Portland, Ore.
Hilke, N. H., International Business Machines Corp., Butte, Mont.
Hill, L. E., Puget Sound Power & Light, Bremerton, Wash.
Palmquist, J. A., Montana Power Co., Great Falls, Mont.
Parker, F. S., General Elec. Co., Portland, Ore.

10. Canada

Allen, G. Y. R., Osborne Electric Co., Ltd., Toronto, Ont., Canada
Cole, R. A., Elec. Lt., R.C.N.V.R., Ottawa, Ont., Canada
Prout, S. M., British Admiralty Technical Mission, Ottawa, Ont., Canada

Elsewhere

Dai, C. C., Tzeliutsing Elec. Works, N.R.C., China
Jamieson, D., Public Works Dept., Auckland, New Zealand
Lundholm, R. O., Royal Board of Waterfalls, Stockholm, Sweden
Mansson, H., Swedish Association of Electricity Works, Stockholm, Sweden
O'Donnell, C. V., Electricity Supply Board, Dublin, Ireland
Reguera, F., J. J. M., Nicaro Nickel Co., Nicaro, Oriente, Cuba
Robinson, J. (Army), 67 Kemp St., Manchester, Lancs., England
Silva, F. S., Nueva Cia. Electrica de Chapala, S. A., Guadalajara, Jal., Mexico
Steventon, P. A., Air Ministry Directorate of Works, London, England
Swayambu, S. I., Office of the Electrical Commissioner, Calcutta, India
Zabludowski, G., General Electric Co., Rio de Janeiro, Brazil, S. A.

Total to grade of Associate
United States and Canada, 132
Elsewhere, 11

OF CURRENT INTEREST

Third Report of National Patent Planning Commission

The basic concept of both patents and copyrights is the assurance to the individual creators of the new and useful an adequate protection of their intellectual property against piracy. The National Patent Planning Commission in its third report issued under date of September 8, 1945, rejects proposals for revision of the patent system of the United States involving a departure from the principles upon which it is founded and by the "effectuation of which it has furthered the nation's industrial and social improvement." This is the philosophy in the main of this report of the Commission which is a résumé of recommendations already made for the information of the President, and a summary of the main subjects and problems now under consideration. A study of the existing patent laws was made as a result of a directive of the President on April 20, 1945, to the Secretary of Commerce to form a committee to offer recommendations respecting legislative proposals to be laid before Congress.

With reference to its first report the Commission advised the adoption of several remedial courses, such as the creation of a single court of patent appeals; establishment by Congress of a reasonable, understandable test of patentability; reference back to the Patent Office of technical questions raised in suits for infringement of patents; all contracts relative to patents be publicly recorded in the United States Patent Office; a term of a patent shall not extend beyond 20 years from the date of the filing of an application, and that the present statutory term of 17 years be retained except in those cases in which more than the three years were consumed in its procurement; simplification of appellate procedure; opportunity afforded the public to challenge the validity of a patent within six months after its grant; creation of a public register, and ruling out the proposal for general compulsory licensing of patents.

In its second report the Commission made recommendations concerning the treatment of Government-owned patents, and inventions of Government employees and contractors.

Currently, the Commission has under consideration the following problems:

1. Elimination or simplification of accounting proceedings to reduce the cost of litigation.
2. Enlargement of the power of the Commissioner of Patents.
3. Incorporation in the tax laws of provisions designed to induce investment of capital in new enterprises, particularly based on new inventions.
4. Reduction of cost and simplification of procedure of patent litigation.
5. Clarification and extension in statutory form of the power of a court to compel the granting of licenses on reasonable terms in the case of a defendant's conviction for violation of the antitrust laws.
6. Greater observance of the presumption of validity of patents.
7. Provision at the Patent Office with more adequate facilities.
8. Making possible the exploitation of so-called use patents, that is, patents involving the use of unpatented materials.
10. Correction of patents for improper joinder or nonjoinder of inventors.
11. Granting of patents to foreigners.
12. Problems relating to the stimulation of discovery and invention in addition to the patent laws.

Predoctoral Fellowships Offered by National Research Council

The National Research Council, Washington, D. C., announces that it is now ready to receive nominations and applications for the predoctoral fellowships in the natural (mathematical, physical, and biological) sciences which it is administering under a grant from the Rockefeller Foundation. These fellowships are intended to assist young men and women, whose graduate study has been prevented or interrupted by the war, to complete their work for the doctorate.

The annual stipend will be $1,200 for single persons and $1,800 for married men. In general it is expected that each recipient will spend at least 11 months per year on academic work. An additional allowance up to $500 per year will be made for tuition fees. Fellowships granted to individuals who are eligible for educational support under the "G.I. Bill of Rights" will be at such stipends as to bring the total income from these two sources to that which would be received at the afore-mentioned rates.

Prospective candidates for these fellowships are urged to apply at once. Information may be obtained by writing to the secretary, committee on predoctoral fellowships, National Research Council, Washington 25, D. C.

Electronics Research at Naval Laboratory

To strengthen research for the naval organization four new scientific divisions dealing with electronics have been established at the Naval Research Laboratory, Washington, D. C. These new divisions, set up by Rear Admiral A. H. Van Keuren, director of the laboratory, will be organized along lines found essential as a result of war experience. They will bring high-grade technical talent into closer contact with fleet operating and maintenance problems. The activities of the laboratory formerly were contained in a single radio division under Doctor A. Hoyt Taylor of Chicago, Ill., who has been named chief consultant and co-ordinator for electronics. The four men appointed as heads of the new divisions are the following: Doctor Robert M. Page, St. Paul, Minn., Doctor John M. Miller, Hanover, Pa., L. A. Gebhard, Buffalo, N. Y., and R. A. Gordon, Hyattsville, Md.

Engineers Would Limit Germany's Industrial Control

Prohibition or control of five war potentials to prevent German rearmament is recommended in a report, "Industrial Disarmament of Aggressor States (Germany)," by the National Engineers Committee of the Engineers Joint Council on which is representation from five engineering societies including AIEE.

Its program for control of German industry based on a year's study by 35 leading engineering and technological specialists was submitted under date of September 21, 1945, to the State, War, and Navy Departments, Commanding General of Army Service Forces, Foreign Economic Administration, since dissolved, and Lieutenant General L. D. Clay, deputy to General Dwight D. Eisenhower, for the Office of Military Government formerly known as the United States Group Control Council for Germany.

Working within the framework of the Yalta and Potsdam agreements, the engineering group concludes that assurance that Germany will keep the peace requires institution and maintenance of all effective controls of power production and distribution and industrial plant construction to:

1. Prohibit synthetic fixation of nitrogen.
2. Prohibit production of synthetic liquid fuels.
3. Prohibit production of aluminum.
4. Prohibit development and use of atomic energy.
5. Limit the capacities and production of steel and steel-products plants.

In addition the program involves the control of scientific research and of economic subsidies from the State.

On the subject of electric power the report recommended that a comprehensive postwar control of German industry be based on a system of energy allocation. Specifically the report states:

> The fundamental factor is energy, since it is required in one form or another to operate all processing equipment for the transformation of all raw materials into finished goods. Therefore, regulations based on energy are so inclusive that all industrial operations fall within their scope.
>
> Control of power distribution through allocation of all coal distribution, while fundamentally effective, would be cumbersome, a handicap to peaceful development, and would require a considerable staff. A rigid control of electric-power distribution is therefore important to ensure compliance and regulation of German industry.
>
> The specific details of electric-power allocation must be formulated by the Office of Military Government possessing firsthand information of the requirements of German industrial and domestic activities. It is assumed that after productive limitations, consistent with the recommendations herein contained, have been determined for German industry, it will be relatively easy to ascertain the energy requirements to supply industrial and domestic needs. All excess capacity above that allotted to a given district, including installations in industrial plants, should be removed and all of the contiguous auxiliaries, building foundations, and other services should be removed or destroyed. It should be realized, however, that the electric-power industry in Germany cannot and should not be used as the sole means of controlling other industries for disarmament purposes. Reports on the use of electric energy by individual manufacturing plants cannot be relied upon as a definite indication of the magnitude and nature of manufacturing operations.

In September 1944, the presidents of the American societies of electrical, civil, mining and metallurgical, mechanical, and chemical engineers in a joint signed statement declared that the proposed destruction of Germany's entire industrial plant is economically unsound and contains the seeds of a new war. The full text of that statement has been published. (*EE, Nov '44, p 393–94*)

Electronics Plant Planned at Syracuse

A university of industry soon will become a reality on 155 acres of ground outside Syracuse, N. Y., as the General Electric Company begins the construction of its new $10,000,000 electronics headquarters plant. Laid out and landscaped like a college campus, the new plant will be known officially as General Electric's "Electronics Park." Here employees will work under the most modern conditions in well-lighted, air-conditioned factory buildings and offices, surrounded by an inspiring park-like atmosphere and reached by modern highways leading to and through the plant.

Doctor Walter Baker (A '19, M '41), vice-president of the company discussing the bright future for electronics said that as chemistry is not limited to plastics or synthetic rubber, neither is electronics limited to radio, communications, or radar; it will contribute to numerous fields and in some cases create new industries, like television.

X-Ray Diffraction Clinic Completed at Polytechnic Institute

Nineteen physicists, engineers, metallurgists and research chemists in industry recently completed a clinic on the industrial application of X-ray diffraction at the Polytechnic Institute of Brooklyn, Brooklyn, N. Y. These men made in daily laboratory sessions an intensive use of the available equipment for the study of all standard techniques in this work. In addition, they had an opportunity to observe the pioneer work in the study of low-angle scattering carried out by Doctor I. Fankuchen, adjunct professor of crystal chemistry, with Doctor Herman F. Mark, international authority on high polymers who heads the high polymer research bureau at the Polytechnic Institute.

The polytechnic X-ray diffraction laboratory contains several new instruments developed by Doctor Fankuchen, who conducted the clinic. One is a microcamera, designed for the study of very small specimens. Another is a pump designed on a simple principle to permit the continuous flow of solutions in front of X-ray beams. Other equipment in the laboratory includes four complete X-ray units, powder cameras of all types, focussing cameras, X-ray monochromators, low-angle scattering cameras, apparatus for single crystal study, and a new equi-inclination Weissenberg goniometer.

Fourteen practicing chemists from leading industrial firms recently completed an intensive study of a number of modern techniques of polymer chemistry at the Institute. Under the direction of Doctor Mark, the clinic was organized as the first move to make research facilities of the Institute available to industrial chemists in a manner not possible in general graduate courses.

Bibliography on Social Impact of Science

As an aid in the study of legislation on science now before Congress, the Subcommittee on War Mobilization of the Senate Military Affairs Committee, issued on September 9, 1945, a select bibliography on "The Social Impact of Science." The bibliography has been prepared by the Library of Congress. It lists more than 500 titles of books, pamphlets, articles, and Congressional bills and reports dealing with the social and economic problems arising from scientific progress. A special section covers the available literature on atomic power, including several volumes not yet published.

Grants for Collegiate Research

Grants amounting to $2,500,000 for postwar collegiate research have been offered by the Research Corporation, New York, N. Y., a nonprofit organization devoted to advancing research and technology by use of revenues from inventions assigned to it by public-spirited inventers. These grants will enable talented young scientists engaged for the most part in war research to undertake at universities and colleges research of peacetime importance in pure science, especially engineering, chemistry, physics, and mathematics.

A five-year program was announced by Doctor J. W. Barker (M '26, F '30) acting president, who is back with the corporation and has returned to Columbia University, New York, N. Y., as dean, faculty of engineering, and professor of electrical engineering. He had been serving as special assistant to the Secretary of the Navy. Included on the special committee which will make the grants are Doctor Barker, and W. D. Coolidge (A '10, M '34) director of research laboratory, General Electric Company, Schenectady, N. Y. Preference in making these grants will be given, other factors being equal, to smaller institutions and those of more limited financial resources.

Cultural Agency in State Department. The State Department of the United States is creating the Office of International Information and Cultural Affairs. Its objectives are stated to be the co-ordination and direction of policies and activities in the field of international information and cultural affairs, the development of policies and programs promoting freedom of information among peoples, and the furtherance of international exchanges of persons, knowledge, and skills.

An "Engineer-in-Training" License. A new "Professional Engineers Registration Law" was passed recently by the Pennsylvania State Legislature. The innovation in this act is the classification "Engineer-in-Training." This provision is made so that an applicant can take his examination in fundamental engineering principles when he is best fitted to do so. If an applicant is a graduate of an approved engineering institution, he is granted a certificate of engineer-in-training without an examination. Thereafter, all he needs to pass, after he has had the required four years of experience, is an examination in engineering practice. Applicants who are not graduates can take these examinations separately or at the same time. The years of experience required of a graduate have been increased to four to meet a similar requirement of all other states. The Act will become effective on June 30, 1946.

Labor Bulletin in New Approach. Out of the 25-year-old *Industrial Bulletin* issued by the State of New York Department of Labor, Albany, has evolved a modern news-and-picture magazine with the September issue. This, too, is a report to the people of the state but with pictures and with quick reading on the labor laws explained in terms of the people. The reports and surveys carried in the former technical bulletin will be relayed in other form to all who find use for them.

OTHER SOCIETIES •

Proposed Simplified Practice For Hot-Rolled Carbon-Steel Structural Shapes

A voluntary simplified practice recommendation for hot-rolled carbon-steel structural shapes, as proposed by the technical committee on carbon-steel plate and structural shapes, of the American Iron and Steel Institute, was made available, during September 1945, to all interests, for their consideration, comment, and approval. The proposal, announced by the division of simplified practice of the National Bureau of Standards, contains 18 tables, covers the nominal sizes and weights per linear foot of sections, beams, stanchions, joists, channels, angles, tees, and zees. Sections and angles used in carbuilding and shipbuilding are included.

Vast Industrial Achievements Foreseen. Accomplishments in the realms of electricity and aviation that would have sounded fantastic before the war were told to members of the Colorado Society of Engineers at its recent midsummer meeting in Denver, Colo. A. C. Streamer (A '10, M '41), vice-president of the Westinghouse Electric Corporation, East Pittsburgh, Pa., and president of the National Electrical Manufacturers Association, stressed the present employment responsibility of industry. He said that the chief purpose in attaining a high-employment goal is to achieve a high standard of living, and that is attained by greater production per man through increased efficiency of machinery and methods and greater personal proficiency. Further he declared that the expected postwar air service pictured by the Air Transport Association is an astounding program. With cruising speeds of more than 300 miles an hour incorporated in many of the new models, the time for crossing the continent would be cut way below the 12- to

14-hour schedules now being regularly flown. Among developments for the more distant future was the turbo-jet power plant, which would provide speeds approaching that of sound.

Prosthetic Devices for Disabled Veterans. Mechanical driver aids for disabled veterans have been developed successfully by engineers of the Society of Automotive Engineers, New York, N. Y. Following a request from the American Society of Motor Vehicle Administrators, a special technical subcommittee of the SAE War Engineering Board started to work on the project, with the result that today Army surgeons report the great majority of injured veterans will be able to drive efficiently and safely. The aids will permit veterans with artificial limbs to operate passenger cars and light trucks. They supplement automatic clutches, drives, and transmissions. For veterans whose legs have been amputated they make it possible to operate the vehicle by hand. For those with artificial hands or arms, they make it possible to manage the controls more easily whether by hand or foot.

Behavior of Dielectrics Discussed. At the September meeting of the Cedar Rapids, Ia., section of the Institute of Radio Engineers R. F. Field (M '40) engineer, General Radio Company, Cambridge, Mass., presented a paper entitled, "The Behavior of Dielectrics Over Wide Ranges of Frequency, Temperature, and Humidity." Supplementing his talk with slides, Mr. Field outlined the theoretical and mathematical aspects of the subject, and demonstrated that such behavior can be predicted to a first approximation when only a few parameters are known.

Welding Officers Meet. A meeting of the national officers, board of directors, and committee chairmen of the American Welding Society was held in New York, N. Y., on October 18, 1945. This group presented the society prizes, medals, and other awards which have been given in past years at the opening sessions to those who made outstanding contributions in the advancement of the science and art of welding.

Aeronautical Institute Will Move. The Institute of Aeronautical Sciences, Inc., publisher of *Aeronautical Engineering Review*, has acquired property for a new headquarters at 2 East 64th Street, facing Central Park, New York, N. Y. Formerly the residence of the late E. J. Berwind, it will be remodeled to provide for the libraries and exhibits of the institute.

New Aluminum Publication. *Aluminum Bulletin*, published by the Aluminum Association, New York, N. Y., made its first appearance under date of September 1945. This pamphlet will be published four times a year and will contain material having specialized rather than popular interest. The twofold purpose is to furnish a medium for reporting both to and from the aluminum industry, about the aluminum industry.

Future Meetings of Other Societies

American Society of Refrigerating Engineers. Forty-first annual meeting. December 10–12, 1945, New York, N. Y.

Institute of Aeronautical Sciences. Wright Brothers Lecture. December 17, 1945, Washington, D. C.

Institute of Radio Engineers. Winter technical meeting. January 23–26, 1946, New York, N. Y.

National Association of Corrosion Engineers. Annual meeting and convention. May 7–9, 1946, Kansas City, Mo.

RESEARCH

Science Controls Urged. A strong national policy for the promotion of science and democratic controls over its products to safeguard civilization was urged at the first seasonal meeting of the American Academy of Political and Social Science, October 5, 1945. Brigadier General David Sarnoff (M '23) president, Radio Corporation of America, declared that the United States must be first in science. He urged the exploration and development of every phase of technology and encouragement for every scientist for it is his belief that youth with an aptitude for science is the country's great national resource. "The Place of Science in a Democracy" was the theme developed by Waldemar Kaempffert, science editor of the *New York Times*, who asserted that it was inevitable that social inventions of fascism and communism would arise because social inventions had failed to keep pace with machine inventions. He declared that already the people are caught in a mechanized culture, and the mechanism of that culture is designed and controlled by the new caste that draws its power from science and technology.

Britain to Speed Research. With the objectives to maintain contact between British companies and research organizations and to encourage British industry to extend and utilize to the fullest its research facilities, Great Britain Federation of British Industries has voted to create a special research committee as liaison between industry and science. Sir William Larke will head the organization.

Technology in Postwar World. The United States "does not intend to play technological Santa Claus to the world" but, to retain its place in the world, technology must be added to the list of its exports. These sentiments were expressed by Maurice Holland (A '23, M '30) before the October 6, 1945, session of the Mexican-American Industrial Research Conference, sponsored by the Armour Research Foundation of the Illinois Institute of Technology, Chicago. He said that technology is the American passport to the postwar world and that in applying it to new industrial enterprises abroad the United States can draw upon its national resources of more than 100 government scientific and technical agencies; 2,500 industrial research laboratories; nearly 100 university and technical-college research centers; and 600 consulting, commercial, and testing laboratories operating in all major fields of industry.

Research Men Meet. More than 100 research directors and other industrial executives discussed common problems of research management at the fall meeting of the Industrial Research Institute, New York, N. Y., September 27–28, 1945. F. B. Jewett (HM '45) president, National Academy of Sciences, as one of the guest speakers, warned that industry must be careful not to jeopardize the future of research by draining colleges of their best teachers and scientific investigators. The group also visited the laboratories of the Radio Corporation of America, Princeton, N. J., where modern facilities for research were shown.

EDUCATION

War Developments Included in Brooklyn Curricula

The Polytechnic Institute of Brooklyn, Brooklyn, N. Y., has revised its electrical-engineering curriculum to include a series of courses based on the new war developments now released from government restriction. In announcing the new courses, Doctor Ernst Weber (F '34), head of the department of graduate study and research in electrical engineering, said that at the present time much of the equipment used in microwave research at the institute cannot be utilized for instructional purposes because it is under secrecy orders, but it is expected that the Government soon will release such orders on all basic scientific equipment developed in the field of microwaves during the war.

As a result of the major developments in the electrical-engineering field, the undergraduate course will have two options. The first will feature electric power and industrial applications and the second, electronics and communications. The first option will include, in addition to the usual work on electric machinery and power transmission, courses on industrial control and industrial electronics. The second option provides a revised curriculum to include the recent developments in ultrahigh frequencies in their application to frequency modulation and television. Both options of the undergraduate program include substantial laboratory work, and in the senior year embrace independent design projects in which the student learns to build up complete power or communications systems.

On the graduate level there is an extensive program in microwaves, generation, transmission, and reception in all phases, courses on servomechanism which proved useful during the war for gun direction of anti-aircraft, the theory of antennas and of television, and all types of modulation circuits.

New courses in electron optics covering the design of electron-focusing systems which produce images in television and other cases have been added to the graduate curriculum

Quarter System Replaces Semester. Because of Navy, Army, and war-training committments, reconversion of the curricula of the Georgia School of Technology, Atlanta, from a wartime to a peacetime basis will be made at the end of the 1945–46 academic year. The new peacetime plan will introduce the quarter system instead of the semester schedule. Under the new system there will be only one commencement each calendar year, and regular students will be granted bachelor-of-science degrees in engineering at the end of their fourth year upon successful completion of prescribed courses. Co-operative students, who spent part of their time in school and the other part in industry, will graduate at the end of five years. With the quarter system students with high scholarship standings will have an opportunity to finish a complete engineering course in three years by pursuing prescribed courses during the summer quarters.

Views Exchanged on Instrumentation. An educational conference "Instrumentation and the University," sponsored by the Carnegie Institute of Technology, Pittsburgh, Pa., and the Instrument Society of America, was held October 16 to 18, 1945, at the institute. The purpose was to provide an opportunity for an exchange of views among industrial-instrument users, Government agencies, instrument manufacturers, and the faculties in engineering and science. Among the speakers were H. B. Richmond (A '19, F '40) chairman of the board, General Radio Company, Cambridge, Mass.; A. F. Sperry (M '37) owner, Hubbard Engineering Company, Chicago, Ill.; and D. A. Young (A '35, M '41) manager, instrument section, meter division, engineering department, Westinghouse Electric Corporation, Newark, N. J. The chairman of the committee for the conference was B. R. Teare, Jr. (A '29, F '42), head of the electrical-engineering department, Carnegie Institute of Technology.

Curricula Changed at Columbus. Five-year curricula, replacing the present four-year programs in all degree-granting departments of the college of engineering, Ohio State University, Columbus, Ohio, became effective with the autumn period. The plan which will bring more of the so-called "cultural" courses into the engineering curricula was introduced with the new freshman class. Present students, returning students whose work was interrupted by the war or for other causes, and students transferring from other colleges will be permitted to choose between the four- and five-year curricula. This option will continue for the next two years.

Gas-Turbine Laboratory at MIT. Gifts totaling $500,000 for the establishment of a gas-turbine laboratory at the Massachusetts Institute of Technology, Cambridge, for graduate instruction and fundamental research have been announced by Doctor J. C. Hunsaker, head of the departments of aeronautical and mechanical engineering. Recent advances in gas-turbine design emphasize the need for specialized technical studies and the discovery of new techniques required in the construction of machines operating at extremely high speed, high temperature, and high compression. The institute's new laboratory, which is to be completed as soon as possible, will include a supersonic wind tunnel and facilities for research on the elements of compressors, combustion devices, jets, and gas turbines. Test facilities also will be provided for operation of such devices.

Gauge Laboratory in Atlanta. Re-establishment of the United States Army Ordnance Department gauge laboratory at the Georgia School of Technology, Atlanta, was announced jointly September 29, 1945, by Doctor B. R. Van Leer, president of the school, and Colonel J. E. Getzen, chief of the Birmingham ordnance district. The new installation, including equipment and air-conditioning facilities, is valued at approximately $150,000. This gauge laboratory was one of the first to be established in an institution outside of the National Bureau of Standards. Part of the equipment saw service in ordnance establishments in Louisiana and part was utilized in war industries in Birmingham.

Naval Trainees at Atlanta Limited. To accommodate the great number of war veterans and civilian students the increase in naval-trainee enrollment at the Georgia School of Technology, Atlanta, is being limited by available dormitory space to ten per cent, which means an increase from 639 to 749 men.

Night Courses in Engineering. The evening engineering program of Rutgers University, New Brunswick, N. J., was resumed on October 1, 1945, by the university extension division after a four-year cessation due to emphasis on war courses. Three-year college-level evening certificates will be offered in essentials of electrical engineering. These evening courses are designed primarily for part-time working students, war workers, and veterans who desire to continue their training.

Conferences on Distribution at Newark. A series of seven weekly conferences on "Engineering for Improved Distribution" has been inaugurated at Newark College of Engineering, Newark, N. J. Discussions will be carried on by two groups, one devoted to "Finding and Using Distribution Facts," and the other to "Promotion and Selling for Improved Distribution." Prominent sales engineers, promotion men, and advertising specialists have been selected as chairmen for the session. In addition to giving informal talks on broadly assigned topics, they will conduct round-table forums for the interchange of ideas. The conferences are endeavoring to co-ordinate production, research, sales, and distribution planning to meet the fullest impact of postwar reconversion.

Broader Training in Troy Curriculum. A postwar undergraduate curriculum developed in line with the scientific advances and social and economic changes coming out of World War II has been set up at Rensselaer Polytechnic Institute, Troy, N. Y. The chief aim, in addition to training students to become proficient engineers and scientists, is to help students understand their duties as intelligent citizens in an era of imposing wider responsibilities. Therefore, time allotted for the study of such subjects as economics, history, psychology, literature, and other nontechnical subjects is increased by a third. Study of mathematics, the sciences, and other fundamental subjects is increased, and specialization is modified in the belief that the college hours of the undergraduate can be spent more profitably in enlarging his comprehension of all the roots of engineering rather than narrowing down too much to those of a special field. All students can enter the third year with essentially a similar background in mathematics and sciences, and can begin in that year to choose options or electives providing emphasis on the special activity they wish to follow after graduation.

Jewett Fellowships Available. For the second year, applications for the Frank B. Jewett Fellowships for post-doctorate research in the physical sciences may now be obtained from the Frank B. Jewett fellowship committee, Bell Telephone Laboratories, 463 West Street, New York 14, N. Y. Applications for the current term are returnable to the committee by December 1, 1945, and awards will be announced February 1, 1946. These fellowships which include chemistry, mathematics, and physics, carry an award of $3,000 to the fellow and an honorarium of $1,500 to the academic institution where his research is pursued. The fellowships are open to both men and women who have obtained the doctorate or expect to receive it prior to the beginning of the fellowship term, which starts July 1, 1946, and ends 12 months later.

INDUSTRY • • • • •

Co-operation Between Government and Manufacturers Urged

Co-operation with the Government and a devotion of energies toward production, a policy which would lead to providing jobs, merchandise for thousands of hard-hit small retailers, and needed radio receivers for a consumer market, was urged by John Meck, president, John Meck Industries, Inc., Plymouth, Ind., who recently spoke before radio-trade-press representatives in New York, N. Y. He said that an attempt to force the hand of the Office of Price Administration by stalling production is contrary to the best interest of all.

The John Meck company, radio manufacturers, claims to be the first in the industry to produce a completely new postwar radio, an OPA-priced five-tube superheterodyne table model known as "The Trailblazer."

Cellulose in "Movies." The industrial film of the Hercules Powder Company, Wilmington, Del., "Careers for Cellulose," will be shown in 20 Latin American countries by the Office of Co-ordinator of Inter-American Affairs. The sound film, in color, now is being translated into Spanish and Portuguese. This behind-the-scenes story of one of America's newest and most colorful industries starts with the cotton fields, then shows the cotton being transformed into cellulose and other bases for plastics, lacquers, film, rayon, and other articles. The film follows the cellulose materials to testing laboratories and then demonstrates the possibilities of cellulose materials in a variety of industries.

Radiotelegraph Services Resumed. The reopening of direct radiotelegraph communications between the United States and Tokyo took place August 28 when the facilities of the Mackay Radio and Telegraph Company, a subsidiary of the American Cable and Radio Corporation, New York, N. Y., were placed in operation for the first time since Pearl Harbor. Radiotelegraph services over the Mackay circuit initially will be limited to official military and government, press, and prisoners-of-war messages. The operation of the Tokyo end of the circuit will be under the direction of the American Army of Occupation.

Steel Company Expands. To carry industrial science deeper into the service of postwar living, the Allegheny Ludlum Steel Corporation, Pittsburgh, Pa., will erect a $2,000,000 research laboratory and experimental center at its headquarters plant, Brackenridge, Pa.

JOINT ACTIVITIES

W. H. Harrison Elected 1945 Hoover Medalist

W. H. Harrison (A '20, F '31) recently elected vice-president in charge of operation and engineering, American Telephone and Telegraph Company, New York, N. Y., has been elected the eighth recipient of the Hoover Medal (1945). He held the above-mentioned position prior to 1940 when he went on leave of absence to head the production division of the War Production Board. He left the latter organization in 1942 to become a brigadier general, United States Army. Later he was promoted to the rank of major general and made chief of the procurement and distribution service, Signal Corps. Upon his release he was awarded the Distinguished Service Medal in a personal presentation by General Brehon B. Somervell.

Mr. Harrison entered the Bell System in 1909 as a repairman for the New York Telephone Company. In 1915 he became engaged in circuit-design work with the Western Electric Company, New York, and joined the staff of the American Telephone and Telegraph Company in 1918. Later he served as equipment and building engineer and plant engineer.

The Hoover Medal was instituted by the late Conrad N. Lauer and its first presentation was made to Herbert Hoover (HM '29) in 1930. Other AIEE members who have been Hoover Medalists are: Gano Dunn (A '91, F '12), 1939, and Gerard Swope (A '99, F '22), 1942.

John Fritz Medal for 1946 Awarded to Zay Jeffries

The John Fritz Medal, "the highest award in engineering," will be given to Zay Jeffries (M '36, F '42) vice-president of the General Electric Company in charge of the chemical department at Pittsfield, Mass., for "leadership in the solution of problems affecting the production, conservation, substitution and the scientific appraisal of metals and alloys." A biographical sketch of him appears elsewhere in this issue.

The John Fritz Medal, established in 1902 by the national professional societies of civil, mining and metallurgical, mechanical, and electrical engineers, is given for notable scientific or industrial achievement, and is international in scope. The first award of the medal was made to John Fritz on his 80th birthday, and the medal for 1945 went to J. L. Savage.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Experience With a Heat-Pump System

To the Editor:

This letter further expands an article published in *Electrical Engineering* entitled "Experience With a Heat-Pump System" (*EE, Oct '44, p 361*).

The maximum theoretical coefficient of performance of a heat-pump system is given by the equation:

$$\text{Cop}=\frac{T_1}{T_1-T_2}$$

in which:

T_1 = condenser temperature
T_2 = evaporator temperature

A simple substitution in this formula of the condenser and evaporator temperatures normally reached in operation will yield values which are several times greater than those actually obtained from the formula based upon energy ratio:

$$\text{Cop}=\frac{W_e+W_w}{W_e}$$

where

W_e = heat supplied from electricity
W_w = heat extracted from well water

This letter is an attempt to analyze qualitatively the various factors which cause this wide discrepancy between actual and ideal. The curve, Figure 1, is plotted with coefficient of performance against electric input to the system for the New Haven, Conn., office building of The United Illuminating Company.

Curve *A*, at unity coefficient of performance for all loads, represents any system of direct electric heating. Curve *F* is a plot of the ideal (Carnot cycle) ratios from the temperature equation mentioned earlier, substituting water temperatures leaving the condenser and evaporator for our specific conditions. Curve *B* shows the coefficient which actually was obtained in operation, as closely as can be determined from the data which have been available. This curve falls off at light loads because of the power required to run the auxiliaries, which is practically constant regardless of the load.

It is the difference between curves *B* and *F*, representing a substantial loss of availability, which is of interest to analyze. Curve *C* shows the coefficient of performance which would have been realized, if no auxiliary power had been required, or to state it differently, if the power consumed by the auxiliaries had been utilized at the same ratio as the power which went to the compressors. It should be noted that these curves do not represent actual energy and that the difference between curves *B* and *C* is not a loss of power. This energy is converted into usable heat but only on a one-to-one basis. The loss is essentially a loss of availability, because this energy fails to convert any low-grade heat from the well water.

Curve *D* carries the same principle one step further and shows the coefficient of performance which would have resulted had it not been necessary to supply power either to the auxiliaries or to make up the losses in the compressor motors. Again this represents a "loss of availability," because a portion of the input is utilized only on a direct one-to-one basis instead of being utilized to convert low-grade heat.

The next higher curve *E* shows the ratios which could have been developed by the hypothetical system of curve *D*, if the heat exchange in its condensers and evaporators had been 100 per cent efficient. Again no loss of energy is involved, but rather a loss of thermal head available, part of which has been required to transfer heat into the re-

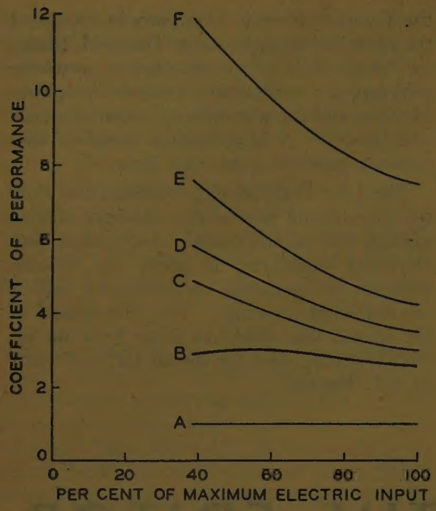

Figure 1. Coefficient of performance: theoretical–actual

A—For direct heating
B—Actual coefficient of performance for heat-pump system
C—With no auxiliary power
D—With no motor losses
E—With 100 per cent efficient heat transfer
F—Theoretical coefficient of performance for Carnot cycle

frigerant and back again. Curve *E*, therefore, represents the maximum coefficient of performance for the cycle. The difference between this line and curve *F* is accounted for by the interaction of all factors which cause the actual cycle to vary from the theoretical Carnot cycle.

Since the top curve represents the maximum possible ratios for a system operating between the temperature limits for this particular set of conditions, any improvement in operating economy must be accomplished by reducing the losses in availability which are shown here.

Of these losses, the first three can be analyzed and evaluated to determine how much gain could be expected. Motor losses are generally well understood, and it is doubtful whether any great improvement can be expected on this item. The other two are involved in a complicated economic balance between many factors. For example, consider the effect of changing the flow quantity of the heat-transfer medium, which in the case of the system described is water. To reduce this flow without any change in the size of equipment will decrease the auxiliary power requirements but increase the necessary temperature differentials. This would mean a reduction in the loss of availability represented by the space between curves *B* and *C* but an increase in that between curves *D* and *E*. To reduce auxiliary power without decreasing flow would require a larger investment in equipment and piping. Obviously, a careful analysis of such a complex interrelation would require a large fund of operating data, and the conclusions from such an analysis would not be necessarily typical of other systems. Although the data presented are neither sufficiently complete nor precise enough to permit a careful evaluation for this particular system, it is believed that the various factors are balanced approximately so that no major gain over the relations shown in Figure 1 could be economically justified.

Therefore, it would seem that any significant improvement over the performance which has been demonstrated by the system described must come from sources which are represented in the Figure 1 by the area between curves *E* and *F*. This is the field of the refrigeration engineer and concerns such technical considerations as compressor design and refrigerant properties.

E. HAVILAND WALTON
CHARLES A. WILLIAM (M '40)
(United Illuminating Company, New Haven, Conn.)

New Frequency Unit

To the Editor:

A need exists for a condensed scale of absolute frequency in cycles per second; and a similar need for frequency ratios. A scheme has been proposed recently based upon classification of frequency decades of electromagnetic wave radiation which includes the descriptive phrases "very low," "very high," and "super high" frequencies. Obviously such phrases are rather arbitrary and have no intrinsic mathematical significance; furthermore, attempts at extension of the scheme must inevitably lead to a terminology including such words as "mammoth" and "colossal."

Since the principal usefulness of a new frequency unit would be as a means of condensing the arithmetic scale, it is evident that a logarithmic scale should be adopted. This would follow the use of "bel" for power ratios in the communication literature, and "pH" for hydrogen ion concentration in the chemical literature.

It is proposed that a new logarithmic unit of frequency be adopted which could justly be called the "marconi" (after a worker who himself ranged over a great many frequencies), and defined as follows:

marconi $= \log_{10} f$ (abbreviated "mi")

in which f is in cycles per second. The ratio of two frequencies would similarly be defined and called the "marconi-ratio," thus

marconi-ratio $= \log_{10} f/f_{\text{base}}$ (abbreviated "mir")

in which f and f_{base} are the variable and base frequencies respectively.

The general adoption of the proposed frequency unit would give formal recognition to the common practice of utilizing logarithmic scales in graphs of frequency functions. The unit would be useful whenever utilizing phenomena defined in terms of "cycles per second," for it could replace such expressions as "a period of 10 seconds" by "−1.0 marconis"; and such cumbersome numbers as "10,000,000 kilocycles per second" by "10 marconis."

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NEW BOOKS ● ● ● ●

The following new books are among those recently received from the publishers. Books designated ESL are available at the Engineering Societies Library; these and thousands of other technical books may be borrowed from the library by mail by AIEE members. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books. All inquiries relating to the purchase of any book reviewed in these columns should be addressed to the publisher of the book in question.

Sampling Statistics and Applications. (Fundamentals of the Theory of Statistics.) By J. G. Smith and A. J. Duncan. McGraw-Hill Book Company, New York, N. Y., and London, England, 1945. 498 pages, diagrams, charts, tables, $8^1/_2$ by $5^1/_4$ inches, cloth, $4. (ESL.)

After reviewing basic concepts and definitions, the authors discuss the general theory of frequency curves and the theory of random sampling. Important sampling distributions are derived, and their applications to a variety of problems are illustrated. Both exact and approximate sampling methods are considered with their proper fields of use. The character of assumptions involved in theory is treated explicitly, and the problems that such assumptions present in practical applications are illustrated.

(The) **Simple Calculation of Electrical Transients.** By G. W. Carter. University Press, Cambridge, England; Macmillan Company, New York, N. Y., 1945. 120 pages, diagrams, tables, $8^1/_4$ by $5^1/_4$ inches, cloth, $1.75. (ESL.)

This small volume provides an elementary treatment of transient problems by Heaviside's operational method in linear electrical circuits with lumped elements. The emphasis is on the physical or engineering side, and many worked examples are given, based on real engineering or laboratory problems. The basic algebra and calculus necessary for a proper understanding of the book have been included in appendixes for those who need the information.

PAMPHLETS ● ● ● ●

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers

Cellulose Acetate—Properties and Uses. (Revised edition.) Hercules Powder Company, Wilmington, Del., unpaged.

Elements of Speech Input Systems (Studio Applications), Western Electric Company, New York, N. Y., 17 pages.

Permanent Magnets for Industry. The Arnold Engineering Company, Chicago 11, Ill., 24 pages.

The Physically Impaired—A Guidebook to Their Employment. Association of Casualty and Surety Executives, New York 7, N. Y., 36 pages.

Patents and Your Tomorrow. National Association of Manufacturers of the United States, New York 20, N. Y., 22 pages.